Wilmington Riverfront Transportation Infrastructure Project

Appendix I: Natural Resources Technical Report

Appendix E: 2D Scour Report (Part 2 of 2 files)

March 29, 2024

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements Prepared by: SNR Date: 2/23/2023 Sheet No.: ____ of ____
County: New Castle Checked by: TMC Date: 3/23/2023 Cm. No.: 20077
Segment: Market Street (to Central Green Outfall) Storm Frequency: 200 -year (50-year for sumps)

Location			Plan Sheet	Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To		A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
				ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
RELOCATED INLET IN SMR																											
P4	**DI19**	**MH1**	CP-1	2405	0	2405	0.06	1.00	0.06	0.06	6.0	0.00	8.09	0.4	15	27.3	0.012	0.000041	0.005	4.1	5.0	2.5	0.19	6.19	4.49	4.35	Q ok
P5	MH1	MH2	CP-1	1	0	1	0.00	1.00	0.00	0.06	6.0	6.19	8.02	0.4	18	82.7	0.012	0.000015	0.005	4.5	8.0	2.2	0.62	6.81	4.25	3.84	Q ok
P7	MH2	MH3	CP-1	1	0	1	0.00	1.00	0.00	0.06	6.0	6.81	7.81	0.4	18	73.8	0.012	0.000014	0.005	4.6	8.1	2.2	0.55	7.36	3.81	3.44	Q ok
P10	MH3	MH4	CP-2	1	0	1	0.00	1.00	0.00	0.30	6.0	7.36	7.60	2.3	18	53.7	0.012	0.000403	0.005	4.6	8.1	3.9	0.23	7.59	3.34	3.07	Q ok
P13	MH4	MH5	CP-2	1	0	1	0.00	1.00	0.00	0.69	6.0	7.59	7.53	5.2	18	59.3	0.012	0.002113	0.005	4.3	7.7	4.7	0.21	7.80	2.97	2.70	Q ok
P15	MH5	MH41	CP-2	1	0	1	0.00	1.00	0.00	1.10	6.0	7.80	7.46	8.2	*24*	**50.0**	0.012	0.001113	0.020	11.0	34.7	9.0	0.09	7.89	2.60	1.60	Q ok
P9	DI3	MH3	CP-1	4110	3259	7369	0.17	0.76	0.13	0.13	6.0	0.00	8.09	1.0	15	18.3	0.012	0.000222	0.005	4.0	4.9	3.0	0.10	6.10	3.68	3.59	Q ok
P8	DI17	MH3	CP-1	3878	2100	5978	0.14	0.85	0.12	0.12	6.0	0.00	8.09	0.9	15	31.3	0.012	0.000182	0.005	4.2	5.2	3.2	0.17	6.17	3.71	3.54	Q ok
P12	DI4	MH4	CP-1	7109	2561	9670	0.22	0.93	0.21	0.21	6.0	0.00	6.73	1.4	15	20.1	0.012	0.000396	0.005	4.0	4.9	3.4	0.10	6.10	3.48	3.38	Q ok
P11	DI18	MH4	CP-1	6435	2210	8645	0.20	0.94	0.19	0.19	6.0	0.00	6.70	1.3	15	28.4	0.012	0.000320	0.005	4.1	5.1	3.4	0.14	6.14	3.48	3.33	Q ok
P14	DI5	MH5	CP-1	4974	2549	7523	0.17	0.86	0.15	0.15	6.0	0.00	8.09	1.2	15	22.6	0.012	0.000296	0.005	4.0	4.9	3.3	0.11	6.11	3.68	3.57	Q ok
P18	DI6	MH6	CP-1	6937	1863	8800	0.20	0.98	0.20	0.20	6.0	0.00	8.09	1.6	15	38.0	0.012	0.000528	0.005	4.0	4.9	3.4	0.18	6.18	4.57	4.38	Q ok
P16	MH6	MH5	CP-2	1	0	1	0.00	1.00	0.00	0.25	6.0	6.18	8.02	2.0	18	40.0	0.012	0.000317	0.011	6.8	12.1	4.8	0.14	6.32	3.77	3.32	Q ok
RELOCATED INLET IN SMR																											
P17	**DI49**	**MH6**	CP-2	2236	105	2341	0.05	1.00	0.05	0.05	6.0	0.00	8.09	0.4	15	33.0	0.012	0.000039	0.005	4.0	4.9	2.4	0.23	6.23	4.19	4.02	Q ok
P32	DI23	MH12	CP-2	5495	1914	7409	0.17	0.94	0.16	0.16	6.0	0.00	8.09	1.3	15	33.31	0.012	0.0003	0.005	4.1	5.0	3.3	0.17	6.17	3.98	3.81	Q ok
P31	DI9	MH12	CP-2	4483	551	5034	0.12	1.00	0.12	0.12	6.0	0.00	8.09	0.9	15	18.3	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.86	3.77	Q ok
P30	MH12	MH11	CP-2	1	0	1	0.00	1.00	0.00	0.28	6.0	6.17	8.02	2.2	18	50.1	0.012	0.0004	0.005	4.5	8.0	3.7	0.22	6.39	3.67	3.42	Q ok
P27	MH11	MH10	CP-2	1	0	1	0.00	1.00	0.00	0.57	6.0	6.39	7.95	4.5	18	73.2	0.012	0.0016	0.005	4.6	8.1	4.7	0.26	6.65	3.39	3.02	Q ok
P25	MH10	MH9	CP-2	1	0	1	0.00	1.00	0.00	0.65	6.0	6.65	7.85	5.1	24	69.68	0.012	0.0004	0.006	6.3	19.7	5.1	0.23	6.88	2.92	2.47	Q ok
P22	MH9	MH8	CP-2	1	0	1	0.00	1.00	0.00	0.83	6.0	6.88	7.78	6.4	24	108.3	0.012	0.0007	0.005	5.5	17.3	5.0	0.36	7.24	2.47	1.93	Q ok
P-80	DI-80	MH-08		9967	0	9967	0.23	1.00	0.23	0.23	6.0	0.00	8.09	1.9	15	49	0.012	0.0007	0.009	5.5	6.8	4.5	0.18	6.18	4.53	4.07	Q ok
P28	DI22	MH11	CP-1	5555	1955	7510	0.17	0.94	0.16	0.16	6.0	0.00	8.09	1.3	15	30.3	0.012	0.0003	0.005	4.0	4.9	3.3	0.15	6.15	3.64	3.49	Q ok
P29	DI8	MH11	CP-1	5120	570	5690	0.13	1.00	0.13	0.13	6.0	0.00	8.09	1.1	15	18.3	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.64	3.55	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements Prepared by: SNR Date: 2/23/2023 Sheet No.: ____ of ____
County: New Castle Checked by: TMC Date: 3/23/2023 Cm. No.: 20077
Segment: Market Street (to Central Green Outfall) Storm Frequency: 200 -year (50-year for sumps)

Location			Plan Sheet	Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To		A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
				ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P26	DI21	MH10	CP-1	2755	930	3685	0.08	0.94	0.08	0.08	6.0	0.00	8.09	0.6	15	18.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.11	6.11	4.02	3.93	Q ok
P23	DI20	MH9	CP-2	3213	1102	4315	0.10	0.94	0.09	0.09	6.0	0.00	8.09	0.8	15	29.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.17	6.17	4.53	4.38	Q ok
P24	DI7	MH9	CP-2	3164	527	3691	0.08	1.00	0.08	0.08	6.0	0.00	8.09	0.7	15	28.02	0.012	0.0001	0.005	4.0	4.9	2.8	0.17	6.17	4.38	4.24	Q ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	7.87	7.87	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.87	7.41	
P5	MH1	MH2	1.20	7.86	7.86	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	7.87	7.93	HGL Too High!
P7	MH2	MH3	1.20	7.86	7.86	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	7.86	7.65	HGL Too High!
P10	MH3	MH4	1.20	7.83	7.83	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	7.86	7.28	HGL Too High!
P13	MH4	MH5	1.20	7.68	7.68	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	7.83	7.09	HGL Too High!
P15	MH5	MH41	1.60	7.54	7.54	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	7.68	7.40	HGL Too High!
P9	DI3	MH3	1.00	7.86	7.86	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.87	6.62	HGL Too High!
P8	DI17	MH3	1.00	7.86	7.86	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.87	6.96	HGL Too High!
P12	DI4	MH4	1.00	7.83	7.83	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	7.84	6.48	HGL Too High!
P11	DI18	MH4	1.00	7.83	7.83	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.84	6.56	HGL Too High!
P14	DI5	MH5	1.00	7.68	7.68	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.69	6.61	HGL Too High!
P18	DI6	MH6	1.00	7.71	7.71	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	7.73	7.13	HGL Too High!
P16	MH6	MH5	1.20	7.68	7.68	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	7.71	7.55	HGL Too High!
P17	DI49	MH6	1.00	7.71	7.71	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.71	7.08	HGL Too High!
P32	DI23	MH12	1.00	7.77	7.77	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	7.78	7.11	HGL Too High!
P31	DI9	MH12	1.00	7.77	7.77	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.77	7.13	HGL Too High!
P30	MH12	MH11	1.60	7.74	7.74	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	7.77	7.48	HGL Too High!
P27	MH11	MH10	1.60	7.62	7.62	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	7.74	7.21	HGL Too High!
P25	MH10	MH9	1.60	7.58	7.58	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	7.62	7.54	HGL Too High!
P22	MH9	MH8	1.60	7.48	7.48	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	7.58	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	7.48	7.48	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	7.53	7.34	HGL Too High!
P28	DI22	MH11	1.00	7.74	7.74	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.75	6.74	HGL Too High!
P29	DI8	MH11	1.00	7.74	7.74	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.75	6.92	HGL Too High!
P26	DI21	MH10	1.00	7.62	7.62	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.62	7.23	HGL Too High!
P23	DI20	MH9	1.00	7.58	7.58	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	7.58	7.38	HGL Too High!
P24	DI7	MH9	1.00	7.58	7.58	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.58	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	8.07	8.07	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.07	7.41	
P5	MH1	MH2	1.20	8.06	8.06	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	8.07	7.93	HGL Too High!
P7	MH2	MH3	1.20	8.06	8.06	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	8.06	7.65	HGL Too High!
P10	MH3	MH4	1.20	8.03	8.03	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	8.06	7.28	HGL Too High!
P13	MH4	MH5	1.20	7.88	7.88	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	8.03	7.09	HGL Too High!
P15	MH5	MH41	1.60	7.74	7.74	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	7.88	7.40	HGL Too High!
P9	DI3	MH3	1.00	8.06	8.06	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.07	6.62	HGL Too High!
P8	DI17	MH3	1.00	8.06	8.06	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.07	6.96	HGL Too High!
P12	DI4	MH4	1.00	8.03	8.03	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	8.04	6.48	HGL Too High!
P11	DI18	MH4	1.00	8.03	8.03	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.04	6.56	HGL Too High!
P14	DI5	MH5	1.00	7.88	7.88	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.89	6.61	HGL Too High!
P18	DI6	MH6	1.00	7.91	7.91	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	7.93	7.13	HGL Too High!
P16	MH6	MH5	1.20	7.88	7.88	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	7.91	7.55	HGL Too High!
P17	DI49	MH6	1.00	7.91	7.91	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.91	7.08	HGL Too High!
P32	DI23	MH12	1.00	7.97	7.97	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	7.98	7.11	HGL Too High!
P31	DI9	MH12	1.00	7.97	7.97	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.97	7.13	HGL Too High!
P30	MH12	MH11	1.60	7.94	7.94	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	7.97	7.48	HGL Too High!
P27	MH11	MH10	1.60	7.82	7.82	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	7.94	7.21	HGL Too High!
P25	MH10	MH9	1.60	7.78	7.78	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	7.82	7.54	HGL Too High!
P22	MH9	MH8	1.60	7.68	7.68	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	7.78	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	7.68	7.68	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	7.73	7.34	HGL Too High!
P28	DI22	MH11	1.00	7.94	7.94	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.95	6.74	HGL Too High!
P29	DI8	MH11	1.00	7.94	7.94	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.95	6.92	HGL Too High!
P26	DI21	MH10	1.00	7.82	7.82	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.82	7.23	HGL Too High!
P23	DI20	MH9	1.00	7.78	7.78	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	7.78	7.38	HGL Too High!
P24	DI7	MH9	1.00	7.78	7.78	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.78	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	11.57	11.57	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.57	7.41	
P5	MH1	MH2	1.20	11.56	11.56	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	11.57	7.93	HGL Too High!
P7	MH2	MH3	1.20	11.56	11.56	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	11.56	7.65	HGL Too High!
P10	MH3	MH4	1.20	11.53	11.53	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	11.56	7.28	HGL Too High!
P13	MH4	MH5	1.20	11.38	11.38	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	11.53	7.09	HGL Too High!
P15	MH5	MH41	1.60	11.24	11.24	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	11.38	7.40	HGL Too High!
P9	DI3	MH3	1.00	11.56	11.56	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.57	6.62	HGL Too High!
P8	DI17	MH3	1.00	11.56	11.56	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.57	6.96	HGL Too High!
P12	DI4	MH4	1.00	11.53	11.53	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	11.54	6.48	HGL Too High!
P11	DI18	MH4	1.00	11.53	11.53	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.54	6.56	HGL Too High!
P14	DI5	MH5	1.00	11.38	11.38	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.39	6.61	HGL Too High!
P18	DI6	MH6	1.00	11.41	11.41	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.43	7.13	HGL Too High!
P16	MH6	MH5	1.20	11.38	11.38	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	11.41	7.55	HGL Too High!
P17	DI49	MH6	1.00	11.41	11.41	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.41	7.08	HGL Too High!
P32	DI23	MH12	1.00	11.47	11.47	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	11.48	7.11	HGL Too High!
P31	DI9	MH12	1.00	11.47	11.47	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.47	7.13	HGL Too High!
P30	MH12	MH11	1.60	11.44	11.44	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	11.47	7.48	HGL Too High!
P27	MH11	MH10	1.60	11.32	11.32	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	11.44	7.21	HGL Too High!
P25	MH10	MH9	1.60	11.28	11.28	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	11.32	7.54	HGL Too High!
P22	MH9	MH8	1.60	11.18	11.18	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	11.28	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	11.18	11.18	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	11.23	7.34	HGL Too High!
P28	DI22	MH11	1.00	11.44	11.44	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.45	6.74	HGL Too High!
P29	DI8	MH11	1.00	11.44	11.44	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.45	6.92	HGL Too High!
P26	DI21	MH10	1.00	11.32	11.32	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.32	7.23	HGL Too High!
P23	DI20	MH9	1.00	11.28	11.28	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	11.28	7.38	HGL Too High!
P24	DI7	MH9	1.00	11.28	11.28	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.28	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	12.07	12.07	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.07	7.41	
P5	MH1	MH2	1.20	12.06	12.06	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	12.07	7.93	HGL Too High!
P7	MH2	MH3	1.20	12.06	12.06	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	12.06	7.65	HGL Too High!
P10	MH3	MH4	1.20	12.03	12.03	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	12.06	7.28	HGL Too High!
P13	MH4	MH5	1.20	11.88	11.88	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	12.03	7.09	HGL Too High!
P15	MH5	MH41	1.60	11.74	11.74	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	11.88	7.40	HGL Too High!
P9	DI3	MH3	1.00	12.06	12.06	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.07	6.62	HGL Too High!
P8	DI17	MH3	1.00	12.06	12.06	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.07	6.96	HGL Too High!
P12	DI4	MH4	1.00	12.03	12.03	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.04	6.48	HGL Too High!
P11	DI18	MH4	1.00	12.03	12.03	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.04	6.56	HGL Too High!
P14	DI5	MH5	1.00	11.88	11.88	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.89	6.61	HGL Too High!
P18	DI6	MH6	1.00	11.91	11.91	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.93	7.13	HGL Too High!
P16	MH6	MH5	1.20	11.88	11.88	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	11.91	7.55	HGL Too High!
P17	DI49	MH6	1.00	11.91	11.91	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.91	7.08	HGL Too High!
P32	DI23	MH12	1.00	11.97	11.97	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	11.98	7.11	HGL Too High!
P31	DI9	MH12	1.00	11.97	11.97	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.97	7.13	HGL Too High!
P30	MH12	MH11	1.60	11.94	11.94	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	11.97	7.48	HGL Too High!
P27	MH11	MH10	1.60	11.82	11.82	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	11.94	7.21	HGL Too High!
P25	MH10	MH9	1.60	11.78	11.78	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	11.82	7.54	HGL Too High!
P22	MH9	MH8	1.60	11.68	11.68	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	11.78	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	11.68	11.68	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	11.73	7.34	HGL Too High!
P28	DI22	MH11	1.00	11.94	11.94	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.95	6.74	HGL Too High!
P29	DI8	MH11	1.00	11.94	11.94	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.95	6.92	HGL Too High!
P26	DI21	MH10	1.00	11.82	11.82	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.82	7.23	HGL Too High!
P23	DI20	MH9	1.00	11.78	11.78	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	11.78	7.38	HGL Too High!
P24	DI7	MH9	1.00	11.78	11.78	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.78	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	12.47	12.47	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.47	7.41	
P5	MH1	MH2	1.20	12.46	12.46	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	12.47	7.93	HGL Too High!
P7	MH2	MH3	1.20	12.46	12.46	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	12.46	7.65	HGL Too High!
P10	MH3	MH4	1.20	12.43	12.43	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	12.46	7.28	HGL Too High!
P13	MH4	MH5	1.20	12.28	12.28	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	12.43	7.09	HGL Too High!
P15	MH5	MH41	1.60	12.14	12.14	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	12.28	7.40	HGL Too High!
P9	DI3	MH3	1.00	12.46	12.46	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.47	6.62	HGL Too High!
P8	DI17	MH3	1.00	12.46	12.46	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.47	6.96	HGL Too High!
P12	DI4	MH4	1.00	12.43	12.43	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.44	6.48	HGL Too High!
P11	DI18	MH4	1.00	12.43	12.43	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.44	6.56	HGL Too High!
P14	DI5	MH5	1.00	12.28	12.28	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.29	6.61	HGL Too High!
P18	DI6	MH6	1.00	12.31	12.31	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.33	7.13	HGL Too High!
P16	MH6	MH5	1.20	12.28	12.28	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	12.31	7.55	HGL Too High!
P17	DI49	MH6	1.00	12.31	12.31	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.31	7.08	HGL Too High!
P32	DI23	MH12	1.00	12.37	12.37	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	12.38	7.11	HGL Too High!
P31	DI9	MH12	1.00	12.37	12.37	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.37	7.13	HGL Too High!
P30	MH12	MH11	1.60	12.34	12.34	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	12.37	7.48	HGL Too High!
P27	MH11	MH10	1.60	12.22	12.22	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	12.34	7.21	HGL Too High!
P25	MH10	MH9	1.60	12.18	12.18	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	12.22	7.54	HGL Too High!
P22	MH9	MH8	1.60	12.08	12.08	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	12.18	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	12.08	12.08	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	12.13	7.34	HGL Too High!
P28	DI22	MH11	1.00	12.34	12.34	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.35	6.74	HGL Too High!
P29	DI8	MH11	1.00	12.34	12.34	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.35	6.92	HGL Too High!
P26	DI21	MH10	1.00	12.22	12.22	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.22	7.23	HGL Too High!
P23	DI20	MH9	1.00	12.18	12.18	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	12.18	7.38	HGL Too High!
P24	DI7	MH9	1.00	12.18	12.18	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.18	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	12.97	12.97	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.97	7.41	
P5	MH1	MH2	1.20	12.96	12.96	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	12.97	7.93	HGL Too High!
P7	MH2	MH3	1.20	12.96	12.96	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	12.96	7.65	HGL Too High!
P10	MH3	MH4	1.20	12.93	12.93	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	12.96	7.28	HGL Too High!
P13	MH4	MH5	1.20	12.78	12.78	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	12.93	7.09	HGL Too High!
P15	MH5	MH41	1.60	12.64	12.64	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	12.78	7.40	HGL Too High!
P9	DI3	MH3	1.00	12.96	12.96	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.97	6.62	HGL Too High!
P8	DI17	MH3	1.00	12.96	12.96	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.97	6.96	HGL Too High!
P12	DI4	MH4	1.00	12.93	12.93	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.94	6.48	HGL Too High!
P11	DI18	MH4	1.00	12.93	12.93	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.94	6.56	HGL Too High!
P14	DI5	MH5	1.00	12.78	12.78	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.79	6.61	HGL Too High!
P18	DI6	MH6	1.00	12.81	12.81	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.83	7.13	HGL Too High!
P16	MH6	MH5	1.20	12.78	12.78	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	12.81	7.55	HGL Too High!
P17	DI49	MH6	1.00	12.81	12.81	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.81	7.08	HGL Too High!
P32	DI23	MH12	1.00	12.87	12.87	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	12.88	7.11	HGL Too High!
P31	DI9	MH12	1.00	12.87	12.87	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.87	7.13	HGL Too High!
P30	MH12	MH11	1.60	12.84	12.84	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	12.87	7.48	HGL Too High!
P27	MH11	MH10	1.60	12.72	12.72	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	12.84	7.21	HGL Too High!
P25	MH10	MH9	1.60	12.68	12.68	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	12.72	7.54	HGL Too High!
P22	MH9	MH8	1.60	12.58	12.58	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	12.68	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	12.58	12.58	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	12.63	7.34	HGL Too High!
P28	DI22	MH11	1.00	12.84	12.84	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.85	6.74	HGL Too High!
P29	DI8	MH11	1.00	12.84	12.84	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.85	6.92	HGL Too High!
P26	DI21	MH10	1.00	12.72	12.72	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.72	7.23	HGL Too High!
P23	DI20	MH9	1.00	12.68	12.68	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	12.68	7.38	HGL Too High!
P24	DI7	MH9	1.00	12.68	12.68	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.68	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	13.67	13.67	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.67	7.41	
P5	MH1	MH2	1.20	13.66	13.66	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	13.67	7.93	HGL Too High!
P7	MH2	MH3	1.20	13.66	13.66	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	13.66	7.65	HGL Too High!
P10	MH3	MH4	1.20	13.63	13.63	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	13.66	7.28	HGL Too High!
P13	MH4	MH5	1.20	13.48	13.48	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	13.63	7.09	HGL Too High!
P15	MH5	MH41	1.60	13.34	13.34	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	13.48	7.40	HGL Too High!
P9	DI3	MH3	1.00	13.66	13.66	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.67	6.62	HGL Too High!
P8	DI17	MH3	1.00	13.66	13.66	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.67	6.96	HGL Too High!
P12	DI4	MH4	1.00	13.63	13.63	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	13.64	6.48	HGL Too High!
P11	DI18	MH4	1.00	13.63	13.63	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.64	6.56	HGL Too High!
P14	DI5	MH5	1.00	13.48	13.48	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.49	6.61	HGL Too High!
P18	DI6	MH6	1.00	13.51	13.51	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.53	7.13	HGL Too High!
P16	MH6	MH5	1.20	13.48	13.48	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	13.51	7.55	HGL Too High!
P17	DI49	MH6	1.00	13.51	13.51	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.51	7.08	HGL Too High!
P32	DI23	MH12	1.00	13.57	13.57	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	13.58	7.11	HGL Too High!
P31	DI9	MH12	1.00	13.57	13.57	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.57	7.13	HGL Too High!
P30	MH12	MH11	1.60	13.54	13.54	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	13.57	7.48	HGL Too High!
P27	MH11	MH10	1.60	13.42	13.42	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	13.54	7.21	HGL Too High!
P25	MH10	MH9	1.60	13.38	13.38	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	13.42	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.28	13.28	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	13.38	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	13.28	13.28	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	13.33	7.34	HGL Too High!
P28	DI22	MH11	1.00	13.54	13.54	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.55	6.74	HGL Too High!
P29	DI8	MH11	1.00	13.54	13.54	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.55	6.92	HGL Too High!
P26	DI21	MH10	1.00	13.42	13.42	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.42	7.23	HGL Too High!
P23	DI20	MH9	1.00	13.38	13.38	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	13.38	7.38	HGL Too High!
P24	DI7	MH9	1.00	13.38	13.38	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.38	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	14.17	14.17	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.17	7.41	
P5	MH1	MH2	1.20	14.16	14.16	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	14.17	7.93	HGL Too High!
P7	MH2	MH3	1.20	14.16	14.16	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.16	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.13	14.13	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	14.16	7.28	HGL Too High!
P13	MH4	MH5	1.20	13.98	13.98	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	14.13	7.09	HGL Too High!
P15	MH5	MH41	1.60	13.84	13.84	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	13.98	7.40	HGL Too High!
P9	DI3	MH3	1.00	14.16	14.16	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.17	6.62	HGL Too High!
P8	DI17	MH3	1.00	14.16	14.16	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.17	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.13	14.13	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	14.14	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.13	14.13	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.14	6.56	HGL Too High!
P14	DI5	MH5	1.00	13.98	13.98	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.99	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.01	14.01	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.03	7.13	HGL Too High!
P16	MH6	MH5	1.20	13.98	13.98	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	14.01	7.55	HGL Too High!
P17	DI49	MH6	1.00	14.01	14.01	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.01	7.08	HGL Too High!
P32	DI23	MH12	1.00	14.07	14.07	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.08	7.11	HGL Too High!
P31	DI9	MH12	1.00	14.07	14.07	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.07	7.13	HGL Too High!
P30	MH12	MH11	1.60	14.04	14.04	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	14.07	7.48	HGL Too High!
P27	MH11	MH10	1.60	13.92	13.92	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	14.04	7.21	HGL Too High!
P25	MH10	MH9	1.60	13.88	13.88	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	13.92	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.78	13.78	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	13.88	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	13.78	13.78	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	13.83	7.34	HGL Too High!
P28	DI22	MH11	1.00	14.04	14.04	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.05	6.74	HGL Too High!
P29	DI8	MH11	1.00	14.04	14.04	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.05	6.92	HGL Too High!
P26	DI21	MH10	1.00	13.92	13.92	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.92	7.23	HGL Too High!
P23	DI20	MH9	1.00	13.88	13.88	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	13.88	7.38	HGL Too High!
P24	DI7	MH9	1.00	13.88	13.88	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.88	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	15.47	15.47	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.47	7.41	
P5	MH1	MH2	1.20	15.46	15.46	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	15.47	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.46	15.46	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	15.46	7.65	HGL Too High!
P10	MH3	MH4	1.20	15.43	15.43	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	15.46	7.28	HGL Too High!
P13	MH4	MH5	1.20	15.28	15.28	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	15.43	7.09	HGL Too High!
P15	MH5	MH41	1.60	15.14	15.14	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	15.28	7.40	HGL Too High!
P9	DI3	MH3	1.00	15.46	15.46	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.47	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.46	15.46	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.47	6.96	HGL Too High!
P12	DI4	MH4	1.00	15.43	15.43	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	15.44	6.48	HGL Too High!
P11	DI18	MH4	1.00	15.43	15.43	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.44	6.56	HGL Too High!
P14	DI5	MH5	1.00	15.28	15.28	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.29	6.61	HGL Too High!
P18	DI6	MH6	1.00	15.31	15.31	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	15.33	7.13	HGL Too High!
P16	MH6	MH5	1.20	15.28	15.28	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	15.31	7.55	HGL Too High!
P17	DI49	MH6	1.00	15.31	15.31	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.31	7.08	HGL Too High!
P32	DI23	MH12	1.00	15.37	15.37	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	15.38	7.11	HGL Too High!
P31	DI9	MH12	1.00	15.37	15.37	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.37	7.13	HGL Too High!
P30	MH12	MH11	1.60	15.34	15.34	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	15.37	7.48	HGL Too High!
P27	MH11	MH10	1.60	15.22	15.22	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	15.34	7.21	HGL Too High!
P25	MH10	MH9	1.60	15.18	15.18	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	15.22	7.54	HGL Too High!
P22	MH9	MH8	1.60	15.08	15.08	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	15.18	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	15.08	15.08	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	15.13	7.34	HGL Too High!
P28	DI22	MH11	1.00	15.34	15.34	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.35	6.74	HGL Too High!
P29	DI8	MH11	1.00	15.34	15.34	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.35	6.92	HGL Too High!
P26	DI21	MH10	1.00	15.22	15.22	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.22	7.23	HGL Too High!
P23	DI20	MH9	1.00	15.18	15.18	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	15.18	7.38	HGL Too High!
P24	DI7	MH9	1.00	15.18	15.18	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.18	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	10.41	10.41	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.41	7.41	
P5	MH1	MH2	1.20	10.40	10.40	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	10.41	7.93	HGL Too High!
P7	MH2	MH3	1.20	10.40	10.40	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	10.40	7.65	HGL Too High!
P10	MH3	MH4	1.20	10.37	10.37	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	10.40	7.28	HGL Too High!
P13	MH4	MH5	1.20	10.22	10.22	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	10.37	7.09	HGL Too High!
P15	MH5	MH41	1.60	10.08	10.08	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	10.22	7.40	HGL Too High!
P9	DI3	MH3	1.00	10.40	10.40	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.41	6.62	HGL Too High!
P8	DI17	MH3	1.00	10.40	10.40	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.41	6.96	HGL Too High!
P12	DI4	MH4	1.00	10.37	10.37	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	10.38	6.48	HGL Too High!
P11	DI18	MH4	1.00	10.37	10.37	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.38	6.56	HGL Too High!
P14	DI5	MH5	1.00	10.22	10.22	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.23	6.61	HGL Too High!
P18	DI6	MH6	1.00	10.25	10.25	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.27	7.13	HGL Too High!
P16	MH6	MH5	1.20	10.22	10.22	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	10.25	7.55	HGL Too High!
P17	DI49	MH6	1.00	10.25	10.25	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.25	7.08	HGL Too High!
P32	DI23	MH12	1.00	10.31	10.31	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	10.32	7.11	HGL Too High!
P31	DI9	MH12	1.00	10.31	10.31	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.31	7.13	HGL Too High!
P30	MH12	MH11	1.60	10.28	10.28	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	10.31	7.48	HGL Too High!
P27	MH11	MH10	1.60	10.16	10.16	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	10.28	7.21	HGL Too High!
P25	MH10	MH9	1.60	10.12	10.12	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	10.16	7.54	HGL Too High!
P22	MH9	MH8	1.60	10.02	10.02	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	10.12	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	10.02	10.02	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	10.07	7.34	HGL Too High!
P28	DI22	MH11	1.00	10.28	10.28	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.29	6.74	HGL Too High!
P29	DI8	MH11	1.00	10.28	10.28	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.29	6.92	HGL Too High!
P26	DI21	MH10	1.00	10.16	10.16	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.16	7.23	HGL Too High!
P23	DI20	MH9	1.00	10.12	10.12	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	10.12	7.38	HGL Too High!
P24	DI7	MH9	1.00	10.12	10.12	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.12	7.48	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	10.61	10.61	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.61	7.41	
P5	MH1	MH2	1.20	10.60	10.60	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	10.61	7.93	HGL Too High!
P7	MH2	MH3	1.20	10.60	10.60	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	10.60	7.65	HGL Too High!
P10	MH3	MH4	1.20	10.57	10.57	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	10.60	7.28	HGL Too High!
P13	MH4	MH5	1.20	10.42	10.42	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	10.57	7.09	HGL Too High!
P15	MH5	MH41	1.60	10.28	10.28	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	10.42	7.40	HGL Too High!
P9	DI3	MH3	1.00	10.60	10.60	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.61	6.62	HGL Too High!
P8	DI17	MH3	1.00	10.60	10.60	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.61	6.96	HGL Too High!
P12	DI4	MH4	1.00	10.57	10.57	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	10.58	6.48	HGL Too High!
P11	DI18	MH4	1.00	10.57	10.57	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.58	6.56	HGL Too High!
P14	DI5	MH5	1.00	10.42	10.42	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.43	6.61	HGL Too High!
P18	DI6	MH6	1.00	10.45	10.45	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.47	7.13	HGL Too High!
P16	MH6	MH5	1.20	10.42	10.42	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	10.45	7.55	HGL Too High!
P17	DI49	MH6	1.00	10.45	10.45	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.45	7.08	HGL Too High!
P32	DI23	MH12	1.00	10.51	10.51	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	10.52	7.11	HGL Too High!
P31	DI9	MH12	1.00	10.51	10.51	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.51	7.13	HGL Too High!
P30	MH12	MH11	1.60	10.48	10.48	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	10.51	7.48	HGL Too High!
P27	MH11	MH10	1.60	10.36	10.36	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	10.48	7.21	HGL Too High!
P25	MH10	MH9	1.60	10.32	10.32	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	10.36	7.54	HGL Too High!
P22	MH9	MH8	1.60	10.22	10.22	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	10.32	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	10.22	10.22	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	10.27	7.34	HGL Too High!
P28	DI22	MH11	1.00	10.48	10.48	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.49	6.74	HGL Too High!
P29	DI8	MH11	1.00	10.48	10.48	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.49	6.92	HGL Too High!
P26	DI21	MH10	1.00	10.36	10.36	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.36	7.23	HGL Too High!
P23	DI20	MH9	1.00	10.32	10.32	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	10.32	7.38	HGL Too High!
P24	DI7	MH9	1.00	10.32	10.32	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.32	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	14.11	14.11	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.11	7.41	
P5	MH1	MH2	1.20	14.10	14.10	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	14.11	7.93	HGL Too High!
P7	MH2	MH3	1.20	14.10	14.10	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.10	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.07	14.07	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	14.10	7.28	HGL Too High!
P13	MH4	MH5	1.20	13.92	13.92	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	14.07	7.09	HGL Too High!
P15	MH5	MH41	1.60	13.78	13.78	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	13.92	7.40	HGL Too High!
P9	DI3	MH3	1.00	14.10	14.10	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.11	6.62	HGL Too High!
P8	DI17	MH3	1.00	14.10	14.10	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.11	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.07	14.07	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	14.08	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.07	14.07	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.08	6.56	HGL Too High!
P14	DI5	MH5	1.00	13.92	13.92	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.93	6.61	HGL Too High!
P18	DI6	MH6	1.00	13.95	13.95	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.97	7.13	HGL Too High!
P16	MH6	MH5	1.20	13.92	13.92	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	13.95	7.55	HGL Too High!
P17	DI49	MH6	1.00	13.95	13.95	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.95	7.08	HGL Too High!
P32	DI23	MH12	1.00	14.01	14.01	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.02	7.11	HGL Too High!
P31	DI9	MH12	1.00	14.01	14.01	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.01	7.13	HGL Too High!
P30	MH12	MH11	1.60	13.98	13.98	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	14.01	7.48	HGL Too High!
P27	MH11	MH10	1.60	13.86	13.86	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	13.98	7.21	HGL Too High!
P25	MH10	MH9	1.60	13.82	13.82	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	13.86	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.72	13.72	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	13.82	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	13.72	13.72	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	13.77	7.34	HGL Too High!
P28	DI22	MH11	1.00	13.98	13.98	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.99	6.74	HGL Too High!
P29	DI8	MH11	1.00	13.98	13.98	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.99	6.92	HGL Too High!
P26	DI21	MH10	1.00	13.86	13.86	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.86	7.23	HGL Too High!
P23	DI20	MH9	1.00	13.82	13.82	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	13.82	7.38	HGL Too High!
P24	DI7	MH9	1.00	13.82	13.82	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.82	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	14.61	14.61	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.61	7.41	
P5	MH1	MH2	1.20	14.60	14.60	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	14.61	7.93	HGL Too High!
P7	MH2	MH3	1.20	14.60	14.60	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.60	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.57	14.57	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	14.60	7.28	HGL Too High!
P13	MH4	MH5	1.20	14.42	14.42	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	14.57	7.09	HGL Too High!
P15	MH5	MH41	1.60	14.28	14.28	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	14.42	7.40	HGL Too High!
P9	DI3	MH3	1.00	14.60	14.60	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.61	6.62	HGL Too High!
P8	DI17	MH3	1.00	14.60	14.60	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.61	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.57	14.57	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	14.58	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.57	14.57	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.58	6.56	HGL Too High!
P14	DI5	MH5	1.00	14.42	14.42	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.43	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.45	14.45	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.47	7.13	HGL Too High!
P16	MH6	MH5	1.20	14.42	14.42	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	14.45	7.55	HGL Too High!
P17	DI49	MH6	1.00	14.45	14.45	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.45	7.08	HGL Too High!
P32	DI23	MH12	1.00	14.51	14.51	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.52	7.11	HGL Too High!
P31	DI9	MH12	1.00	14.51	14.51	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.51	7.13	HGL Too High!
P30	MH12	MH11	1.60	14.48	14.48	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	14.51	7.48	HGL Too High!
P27	MH11	MH10	1.60	14.36	14.36	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	14.48	7.21	HGL Too High!
P25	MH10	MH9	1.60	14.32	14.32	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	14.36	7.54	HGL Too High!
P22	MH9	MH8	1.60	14.22	14.22	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	14.32	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	14.22	14.22	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	14.27	7.34	HGL Too High!
P28	DI22	MH11	1.00	14.48	14.48	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.49	6.74	HGL Too High!
P29	DI8	MH11	1.00	14.48	14.48	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.49	6.92	HGL Too High!
P26	DI21	MH10	1.00	14.36	14.36	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.36	7.23	HGL Too High!
P23	DI20	MH9	1.00	14.32	14.32	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	14.32	7.38	HGL Too High!
P24	DI7	MH9	1.00	14.32	14.32	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.32	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	15.01	15.01	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.01	7.41	
P5	MH1	MH2	1.20	15.00	15.00	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	15.01	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.00	15.00	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	15.00	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.97	14.97	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	15.00	7.28	HGL Too High!
P13	MH4	MH5	1.20	14.82	14.82	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	14.97	7.09	HGL Too High!
P15	MH5	MH41	1.60	14.68	14.68	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	14.82	7.40	HGL Too High!
P9	DI3	MH3	1.00	15.00	15.00	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.01	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.00	15.00	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.01	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.97	14.97	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	14.98	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.97	14.97	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.98	6.56	HGL Too High!
P14	DI5	MH5	1.00	14.82	14.82	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.83	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.85	14.85	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.87	7.13	HGL Too High!
P16	MH6	MH5	1.20	14.82	14.82	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	14.85	7.55	HGL Too High!
P17	DI49	MH6	1.00	14.85	14.85	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.85	7.08	HGL Too High!
P32	DI23	MH12	1.00	14.91	14.91	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.92	7.11	HGL Too High!
P31	DI9	MH12	1.00	14.91	14.91	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.91	7.13	HGL Too High!
P30	MH12	MH11	1.60	14.88	14.88	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	14.91	7.48	HGL Too High!
P27	MH11	MH10	1.60	14.76	14.76	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	14.88	7.21	HGL Too High!
P25	MH10	MH9	1.60	14.72	14.72	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	14.76	7.54	HGL Too High!
P22	MH9	MH8	1.60	14.62	14.62	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	14.72	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	14.62	14.62	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	14.67	7.34	HGL Too High!
P28	DI22	MH11	1.00	14.88	14.88	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.89	6.74	HGL Too High!
P29	DI8	MH11	1.00	14.88	14.88	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.89	6.92	HGL Too High!
P26	DI21	MH10	1.00	14.76	14.76	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.76	7.23	HGL Too High!
P23	DI20	MH9	1.00	14.72	14.72	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	14.72	7.38	HGL Too High!
P24	DI7	MH9	1.00	14.72	14.72	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.72	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	15.51	15.51	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.51	7.41	
P5	MH1	MH2	1.20	15.50	15.50	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	15.51	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.50	15.50	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	15.50	7.65	HGL Too High!
P10	MH3	MH4	1.20	15.47	15.47	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	15.50	7.28	HGL Too High!
P13	MH4	MH5	1.20	15.32	15.32	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	15.47	7.09	HGL Too High!
P15	MH5	MH41	1.60	15.18	15.18	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	15.32	7.40	HGL Too High!
P9	DI3	MH3	1.00	15.50	15.50	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.51	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.50	15.50	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.51	6.96	HGL Too High!
P12	DI4	MH4	1.00	15.47	15.47	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	15.48	6.48	HGL Too High!
P11	DI18	MH4	1.00	15.47	15.47	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.48	6.56	HGL Too High!
P14	DI5	MH5	1.00	15.32	15.32	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.33	6.61	HGL Too High!
P18	DI6	MH6	1.00	15.35	15.35	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	15.37	7.13	HGL Too High!
P16	MH6	MH5	1.20	15.32	15.32	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	15.35	7.55	HGL Too High!
P17	DI49	MH6	1.00	15.35	15.35	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.35	7.08	HGL Too High!
P32	DI23	MH12	1.00	15.41	15.41	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	15.42	7.11	HGL Too High!
P31	DI9	MH12	1.00	15.41	15.41	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.41	7.13	HGL Too High!
P30	MH12	MH11	1.60	15.38	15.38	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	15.41	7.48	HGL Too High!
P27	MH11	MH10	1.60	15.26	15.26	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	15.38	7.21	HGL Too High!
P25	MH10	MH9	1.60	15.22	15.22	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	15.26	7.54	HGL Too High!
P22	MH9	MH8	1.60	15.12	15.12	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	15.22	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	15.12	15.12	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	15.17	7.34	HGL Too High!
P28	DI22	MH11	1.00	15.38	15.38	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.39	6.74	HGL Too High!
P29	DI8	MH11	1.00	15.38	15.38	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.39	6.92	HGL Too High!
P26	DI21	MH10	1.00	15.26	15.26	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.26	7.23	HGL Too High!
P23	DI20	MH9	1.00	15.22	15.22	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	15.22	7.38	HGL Too High!
P24	DI7	MH9	1.00	15.22	15.22	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.22	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	16.21	16.21	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.21	7.41	
P5	MH1	MH2	1.20	16.20	16.20	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	16.21	7.93	HGL Too High!
P7	MH2	MH3	1.20	16.20	16.20	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	16.20	7.65	HGL Too High!
P10	MH3	MH4	1.20	16.17	16.17	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	16.20	7.28	HGL Too High!
P13	MH4	MH5	1.20	16.02	16.02	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	16.17	7.09	HGL Too High!
P15	MH5	MH41	1.60	15.88	15.88	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	16.02	7.40	HGL Too High!
P9	DI3	MH3	1.00	16.20	16.20	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.21	6.62	HGL Too High!
P8	DI17	MH3	1.00	16.20	16.20	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.21	6.96	HGL Too High!
P12	DI4	MH4	1.00	16.17	16.17	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	16.18	6.48	HGL Too High!
P11	DI18	MH4	1.00	16.17	16.17	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.18	6.56	HGL Too High!
P14	DI5	MH5	1.00	16.02	16.02	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.03	6.61	HGL Too High!
P18	DI6	MH6	1.00	16.05	16.05	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	16.07	7.13	HGL Too High!
P16	MH6	MH5	1.20	16.02	16.02	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	16.05	7.55	HGL Too High!
P17	DI49	MH6	1.00	16.05	16.05	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.05	7.08	HGL Too High!
P32	DI23	MH12	1.00	16.11	16.11	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	16.12	7.11	HGL Too High!
P31	DI9	MH12	1.00	16.11	16.11	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.11	7.13	HGL Too High!
P30	MH12	MH11	1.60	16.08	16.08	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	16.11	7.48	HGL Too High!
P27	MH11	MH10	1.60	15.96	15.96	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	16.08	7.21	HGL Too High!
P25	MH10	MH9	1.60	15.92	15.92	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	15.96	7.54	HGL Too High!
P22	MH9	MH8	1.60	15.82	15.82	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	15.92	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	15.82	15.82	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	15.87	7.34	HGL Too High!
P28	DI22	MH11	1.00	16.08	16.08	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.09	6.74	HGL Too High!
P29	DI8	MH11	1.00	16.08	16.08	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.09	6.92	HGL Too High!
P26	DI21	MH10	1.00	15.96	15.96	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.96	7.23	HGL Too High!
P23	DI20	MH9	1.00	15.92	15.92	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	15.92	7.38	HGL Too High!
P24	DI7	MH9	1.00	15.92	15.92	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.92	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	16.71	16.71	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.71	7.41	
P5	MH1	MH2	1.20	16.70	16.70	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	16.71	7.93	HGL Too High!
P7	MH2	MH3	1.20	16.70	16.70	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	16.70	7.65	HGL Too High!
P10	MH3	MH4	1.20	16.67	16.67	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	16.70	7.28	HGL Too High!
P13	MH4	MH5	1.20	16.52	16.52	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	16.67	7.09	HGL Too High!
P15	MH5	MH41	1.60	16.38	16.38	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	16.52	7.40	HGL Too High!
P9	DI3	MH3	1.00	16.70	16.70	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.71	6.62	HGL Too High!
P8	DI17	MH3	1.00	16.70	16.70	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.71	6.96	HGL Too High!
P12	DI4	MH4	1.00	16.67	16.67	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	16.68	6.48	HGL Too High!
P11	DI18	MH4	1.00	16.67	16.67	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.68	6.56	HGL Too High!
P14	DI5	MH5	1.00	16.52	16.52	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.53	6.61	HGL Too High!
P18	DI6	MH6	1.00	16.55	16.55	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	16.57	7.13	HGL Too High!
P16	MH6	MH5	1.20	16.52	16.52	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	16.55	7.55	HGL Too High!
P17	DI49	MH6	1.00	16.55	16.55	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.55	7.08	HGL Too High!
P32	DI23	MH12	1.00	16.61	16.61	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	16.62	7.11	HGL Too High!
P31	DI9	MH12	1.00	16.61	16.61	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.61	7.13	HGL Too High!
P30	MH12	MH11	1.60	16.58	16.58	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	16.61	7.48	HGL Too High!
P27	MH11	MH10	1.60	16.46	16.46	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	16.58	7.21	HGL Too High!
P25	MH10	MH9	1.60	16.42	16.42	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	16.46	7.54	HGL Too High!
P22	MH9	MH8	1.60	16.32	16.32	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	16.42	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	16.32	16.32	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	16.37	7.34	HGL Too High!
P28	DI22	MH11	1.00	16.58	16.58	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.59	6.74	HGL Too High!
P29	DI8	MH11	1.00	16.58	16.58	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.59	6.92	HGL Too High!
P26	DI21	MH10	1.00	16.46	16.46	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.46	7.23	HGL Too High!
P23	DI20	MH9	1.00	16.42	16.42	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	16.42	7.38	HGL Too High!
P24	DI7	MH9	1.00	16.42	16.42	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.42	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	200	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	18.01	18.01	15	0.4	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.01	7.41	
P5	MH1	MH2	1.20	18.00	18.00	18	0.4	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	18.01	7.93	HGL Too High!
P7	MH2	MH3	1.20	18.00	18.00	18	0.4	0.2	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	18.00	7.65	HGL Too High!
P10	MH3	MH4	1.20	17.97	17.97	18	2.3	1.3	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	0.9	0.7	0.8	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	18.00	7.28	HGL Too High!
P13	MH4	MH5	1.20	17.82	17.82	18	5.2	3.0	84	59.3	0.0021	0.13	0	0.00	0.03	3.0	1.6	1.3	1.3	0.0	8	0.00	0.05	1.0	0.5	0.02	0.15	17.97	7.09	HGL Too High!
P15	MH5	MH41	1.60	17.68	17.68	24	8.2	2.6	90	50	0.0011	0.06	0	0.00	0.03	15.5	1.2	2.3	3.0	0.0	84	0.09	0.17	1.0	0.5	0.08	0.14	17.82	7.40	HGL Too High!
P9	DI3	MH3	1.00	18.00	18.00	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.01	6.62	HGL Too High!
P8	DI17	MH3	1.00	18.00	18.00	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.01	6.96	HGL Too High!
P12	DI4	MH4	1.00	17.97	17.97	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	17.98	6.48	HGL Too High!
P11	DI18	MH4	1.00	17.97	17.97	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.98	6.56	HGL Too High!
P14	DI5	MH5	1.00	17.82	17.82	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.83	6.61	HGL Too High!
P18	DI6	MH6	1.00	17.85	17.85	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	17.87	7.13	HGL Too High!
P16	MH6	MH5	1.20	17.82	17.82	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.01	2.1	0.2	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.02	17.85	7.55	HGL Too High!
P17	DI49	MH6	1.00	17.85	17.85	15	0.4	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.85	7.08	HGL Too High!
P32	DI23	MH12	1.00	17.91	17.91	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	17.92	7.11	HGL Too High!
P31	DI9	MH12	1.00	17.91	17.91	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.91	7.13	HGL Too High!
P30	MH12	MH11	1.60	17.88	17.88	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	17.91	7.48	HGL Too High!
P27	MH11	MH10	1.60	17.76	17.76	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	17.88	7.21	HGL Too High!
P25	MH10	MH9	1.60	17.72	17.72	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	17.76	7.54	HGL Too High!
P22	MH9	MH8	1.60	17.62	17.62	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	17.72	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	17.62	17.62	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	17.67	7.34	HGL Too High!
P28	DI22	MH11	1.00	17.88	17.88	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.89	6.74	HGL Too High!
P29	DI8	MH11	1.00	17.88	17.88	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.89	6.92	HGL Too High!
P26	DI21	MH10	1.00	17.76	17.76	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.76	7.23	HGL Too High!
P23	DI20	MH9	1.00	17.72	17.72	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	17.72	7.38	HGL Too High!
P24	DI7	MH9	1.00	17.72	17.72	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.72	7.48	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 2 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: Central Green Outfall | Storm Frequency: 500 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-41	MH-41	MH-42	1	0	1	0.00	1.00	0.00	1.10	6.0	7.89	7.80	8.55	24	92	0.012	0.001217	0.0033	4.5	14.0	4.7	0.33	8.22	1.50	1.20	Q ok
P-42	MH-42	DI-43	1	0	1	0.00	1.00	0.00	2.15	6.0	8.22	7.69	16.53	**30**	30	0.012	0.001384	0.0030	5.0	24.3	5.4	0.09	8.31	1.10	1.01	Q ok
P-43	DI-43	DI-44	4208	31	4239	0.10	1.00	0.10	2.25	6.0	8.31	7.65	17.20	**30**	25	0.012	0.001498	0.0032	5.1	25.1	5.6	0.07	8.38	0.91	0.83	Q ok
P-44	DI-44	DI-45	4675	523	5198	0.12	1.00	0.12	2.37	6.0	8.38	7.62	18.02	**30**	69	0.012	0.001645	0.0030	5.0	24.5	5.5	0.21	8.59	0.73	0.52	Q ok
P-45	DI-45	MH-46	4490	535	5025	0.12	1.00	0.12	2.48	6.0	8.59	7.54	18.72	30	52	0.012	0.001774	0.0031	5.0	24.6	5.6	0.16	8.75	0.42	0.26	Q ok
P-46	MH-46	DI-47	1	0	1	0.00	1.00	0.00	3.22	6.0	8.75	7.50	24.15	30	42	0.012	0.002953	0.0031	5.0	24.7	5.9	0.12	8.86	0.16	0.03	Q ok
P-47	DI-47	MH-60	4551	287	4838	0.11	1.00	0.11	3.33	6.0	8.86	7.43	24.73	36	23	0.012	0.001171	0.0030	5.6	39.9	5.9	0.06	8.93	-0.07	-0.14	Q ok
P-60	MH-60	MH-61	1	0	1	0.00	1.00	0.00	4.54	6.0	8.93	7.43	33.73	36	75	0.012	0.002179	0.0039	6.4	44.9	7.1	0.18	9.11	-0.24	-0.53	Q ok
P-61	MH-61	DI-62	1	0	1	0.00	1.00	0.00	4.54	6.0	9.11	7.35	33.39	36	76	0.012	0.002136	0.0039	6.4	45.4	7.1	0.18	9.28	-0.63	-0.93	Q ok
P-62	DI-62	DI-63	1435	40	1475	0.03	1.00	0.03	4.57	6.0	9.28	7.28	33.30	36	50	0.012	0.002124	0.0040	6.5	45.7	7.2	0.12	9.40	-1.03	-1.23	Q ok
P-63	DI-63	DI-77	1999	107	2106	0.05	1.00	0.05	5.36	6.0	9.40	7.24	38.84	*36*	25	0.012	0.002890	0.0036	6.1	43.4	7.0	0.06	9.46	-1.33	-1.42	Q ok
P-77	DI-77	DI-85	2311	122	2433	0.06	1.00	0.06	6.64	6.0	9.46	7.21	47.85	**48**	50	0.012	0.000945	0.0030	6.8	85.2	6.9	0.12	9.58	-1.52	-1.67	Q ok
P-85	DI-85	MH-86	5006	304	5310	0.12	1.00	0.12	11.74	6.0	9.58	7.17	84.15	60	186	0.012	0.000890	0.0030	7.9	154.8	8.0	0.39	9.97	-1.77	-2.33	Q ok
P-86	MH-86	MH-87	1	0	1	0.00	1.00	0.00	12.49	6.0	9.97	7.02	87.65	60	45	0.012	0.000965	0.0031	8.0	157.4	8.2	0.09	10.06	-2.43	-2.57	Q ok
P-87	**MH-87**	**OUTFALL**	**1**	**0**	**1**	**0.00**	**1.00**	**0.00**	**13.30**	**6.0**	**10.06**	**7.00**	**93.07**	**60**	**9**	**0.012**	**0.001088**	**0.0033**	**8.3**	**162.9**	**8.5**	**0.02**	**10.08**	**-2.67**	**-2.70**	**Q ok**
P-48	MSS MH-08	MH-49	1	0	1	0.00	1.00	0.00	1.05	6.0	7.22	8.06	8.50	24	64	0.012	0.001203	0.0070	6.5	20.6	6.0	0.18	7.39	1.65	1.20	Q ok
P-50	B7 North	1.00	32048	0	32048	0.74	1.00	0.74	0.74	6.0	0.00	8.51	6.26	18	16	0.012	0.003026	0.0050	4.6	8.0	5.1	0.05	6.05	0.35	0.27	Q ok
P-65	B7 West	MH-64	32234	0	32234	0.74	1.00	0.74	0.74	6.0	0.00	8.51	6.30	18	17	0.012	0.003061	0.0047	4.4	7.8	4.9	0.06	6.06	-0.95	-1.03	Q ok
P-64	MH-64	DI-63	1	0	1	0.00	1.00	0.00	0.74	6.0	6.06	8.47	6.27	18	20	0.012	0.003034	0.0050	4.6	8.0	5.1	0.07	6.12	-1.13	-1.23	Q ok
P-51	DI-51	DI-52	3030	31	3061	0.07	1.00	0.07	0.07	6.0	0.00	8.51	0.60	15	26	0.012	0.000073	0.0050	4.0	4.9	2.4	0.18	6.18	3.70	3.57	Q ok
P-52	DI-52	DI-53	4699	521	5220	0.12	1.00	0.12	0.19	6.0	6.18	8.43	1.60	15	69	0.012	0.000525	0.0049	4.0	4.9	3.6	0.32	6.50	3.37	3.03	Q ok
P-53	DI-53	MH-54	4484	537	5021	0.12	1.00	0.12	0.31	6.0	6.50	8.32	2.54	15	51	0.012	0.001319	0.0051	4.1	5.0	4.0	0.21	6.71	2.83	2.57	Q ok
P-54	MH-54	DI-55	1	0	1	0.00	1.00	0.00	1.07	6.0	6.71	8.25	8.86	24	41	0.012	0.001306	0.0049	5.4	17.1	5.4	0.13	6.84	2.37	2.17	Q ok
P-55	DI-55	MH-60	5685	291	5976	0.14	1.00	0.14	1.21	6.0	6.84	8.21	9.94	**24**	23	0.012	0.001647	0.0052	5.6	17.7	5.7	0.07	6.90	1.97	1.85	Q ok
P-56	B5 South	MH-54	33482	0	33482	0.77	1.00	0.77	0.77	6.0	0.00	8.51	6.54	18	17	0.012	0.003302	0.0053	4.7	8.3	5.2	0.05	6.05	2.56	2.47	Q ok
P-78	DI-78	DI-79	3667	223	3890	0.09	1.00	0.09	0.09	6.0	0.00	8.51	0.76	15	84	0.012	0.000118	0.0200	8.1	9.9	4.8	0.29	6.29	7.12	5.44	Q ok
P-79	DI-79	DI-71	3253	204	3457	0.08	1.00	0.08	0.17	6.0	6.29	8.40	1.42	18	29	0.012	0.000155	0.0200	9.1	16.1	5.5	0.09	6.38	5.24	4.66	Q ok
P-71	DI-71	DI-72	3698	198	3896	0.09	1.00	0.09	0.35	6.0	6.38	8.36	2.94	18	42	0.012	0.000668	0.0200	9.1	16.1	6.8	0.10	6.48	4.46	3.62	Q ok
P-72	DI-72	DI-73	2021	16	2037	0.05	1.00	0.05	0.40	6.0	6.48	8.32	3.32	18	29	0.012	0.000850	0.0200	9.1	16.1	6.8	0.07	6.55	3.42	2.84	Q ok
P-73	DI-73	MH-74	1071	0	1071	0.02	1.00	0.02	0.42	6.0	6.55	8.28	3.51	18	17	0.012	0.000950	0.0200	9.1	16.1	6.8	0.04	6.59	2.64	2.30	Q ok
P-74	MH-74	DI-75	1	0	1	0.00	1.00	0.00	1.13	6.0	6.59	8.28	9.33	18	17	0.012	0.006720	0.0200	9.1	16.1	9.6	0.03	6.62	2.10	1.76	Q ok
P-75	DI-75	DI-76	2135	0	2135	0.05	1.00	0.05	1.18	6.0	6.62	8.28	9.73	18	43	0.012	0.007318	0.0200	9.1	16.1	9.6	0.07	6.70	1.56	0.70	Q ok
P-76	DI-76	DI-77	1993	48	2041	0.05	1.00	0.05	1.22	6.0	6.70	8.25	10.08	18	51	0.012	0.007842	0.0200	9.1	16.1	9.7	0.09	6.78	0.50	-0.52	Q ok
P-70	DI-70	DI-71	3812	274	4086	0.09	1.00	0.09	0.09	6.0	0.00	8.51	0.80	15	86	0.012	0.000130	0.0200	8.1	9.9	4.8	0.30	6.30	6.38	4.66	Q ok
P-80	DI-80	MH-74	22886	15258	38144	0.88	0.80	0.70	0.70	6.0	0.00	8.51	5.98	18	24	0.012	0.002760	0.0050	4.6	8.0	5.1	0.08	6.08	2.42	2.30	Q ok
P-90	DI-90	DI-91	6026	1962	7988	0.18	0.95	0.17	0.17	6.0	0.00	8.51	1.48	15	79	0.012	0.000450	0.0200	8.1	9.9	5.6	0.23	6.23	2.54	0.96	Q ok
P-91	DI-91	MH-87	6475	2667	9142	0.21	0.91	0.19	0.81	6.0	6.23	8.43	6.86	18	81	0.012	0.003639	0.0200	9.1	16.1	8.8	0.15	6.39	-0.04	-1.66	Q ok
P-92	B6 North	DI-91	19569	0	19569	0.45	1.00	0.45	0.45	6.0	0.00	8.51	3.82	18	63	0.012	0.001128	0.0049	4.5	8.0	4.5	0.23	6.23	0.47	0.16	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 2 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: Central Green Outfall | Storm Frequency: 500 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-95	TD-04	MH-86	21353	32030	53383	1.23	0.61	0.75	0.75	6.0	0.00	8.51	6.36	12	16	0.011	0.022817	0.0506	12.1	9.5	12.9	0.02	6.02	8.01	7.20	Q ok
P-38	DI-38	DI-39	1483	0	1483	0.03	1.00	0.03	0.03	6.0	0.00	8.51	0.29	15	99	0.012	0.000017	0.0200	8.1	9.9	4.0	0.42	6.42	2.75	0.77	Q ok
P-39	DI-39	DI-40	3833	220	4053	0.09	1.00	0.09	0.13	6.0	6.42	8.36	1.06	15	70	0.012	0.000230	0.0200	8.1	9.9	4.8	0.24	6.66	0.57	-0.83	Q ok
P-40	DI-40	DI-85	4668	293	4961	0.11	1.00	0.11	0.24	6.0	6.66	8.25	1.99	18	26	0.012	0.000305	0.0208	9.3	16.4	5.6	0.08	6.74	-1.03	-1.57	Q ok
P-35	MH-35	DI-36	1	0	1	0.00	1.00	0.00	4.60	6.0	7.38	7.99	36.73	**36**	94	0.012	0.002585	0.0050	7.2	51.1	7.9	0.20	7.57	-0.16	-0.63	Q ok
P-36	DI-36	DI-37	1851	0	1851	0.04	1.00	0.04	4.64	6.0	7.57	7.91	36.73	**36**	98	0.012	0.002584	0.0050	7.2	51.1	7.9	0.21	7.78	-0.73	-1.22	Q ok
P-37	DI-37	DI-85	3893	195	4088	0.09	1.00	0.09	4.74	6.0	7.78	7.84	37.12	36	70	0.012	0.002639	0.0050	7.2	51.1	8.0	0.15	7.93	-1.32	-1.67	Q ok
P-30	DI-30	MH-35	1403	0	1403	0.03	1.00	0.03	0.03	6.0	0.00	8.51	0.27	18	47	0.012	0.000006	0.0200	9.1	16.1	4.5	0.18	6.18	0.98	0.04	Q ok
P-11	DI-11	DI-12	4746	684	5430	0.12	1.00	0.12	0.12	6.0	0.00	8.51	1.06	15	20	0.012	0.000230	0.0065	4.6	5.6	3.4	0.10	6.10	2.91	2.78	Q ok
P-12	DI-12	DI-13	4957	1287	6244	0.14	0.99	0.14	0.27	6.0	6.10	8.47	2.26	15	92	0.012	0.001040	0.0065	4.6	5.7	4.2	0.36	6.46	2.68	2.08	Q ok
P-13	DI-13	MH-14	4947	1296	6243	0.14	0.99	0.14	0.41	6.0	6.46	8.32	3.40	15	54	0.012	0.002354	0.0065	4.6	5.6	4.8	0.19	6.65	1.98	1.63	Q ok
P-14	MH-14	DI-15	1	0	1	0.00	1.00	0.00	1.14	6.0	6.65	8.28	9.45	24	38	0.012	0.001488	0.0066	6.3	19.9	6.3	0.10	6.75	1.53	1.28	Q ok
P-15	DI-15	DI-16	3998	870	4868	0.11	1.00	0.11	1.25	6.0	6.75	8.25	10.33	24	73	0.012	0.001777	0.0064	6.3	19.7	6.4	0.19	6.94	1.18	0.71	Q ok
P-16	DI-16	MH-17	5113	501	5614	0.13	1.00	0.13	1.38	6.0	6.94	8.17	11.29	24	31	0.012	0.002123	0.0071	6.6	20.6	6.7	0.08	7.01	0.61	0.39	Q ok
P-18	B7 South	MH-14	31929	0	31929	0.73	1.00	0.73	0.73	6.0	0.00	8.51	6.24	18	17	0.012	0.003003	0.0053	4.7	8.3	5.2	0.05	6.05	1.72	1.63	Q ok
P-01	DI-01	DI-02	7520	1261	8781	0.20	1.00	0.20	0.20	6.0	0.00	8.51	1.72	15	77	0.012	0.000601	0.0065	4.6	5.6	3.9	0.33	6.33	2.91	2.41	Q ok
P-02	DI-02	DI-03	2113	487	2600	0.06	1.00	0.06	0.26	6.0	6.33	8.40	2.19	15	38	0.012	0.000983	0.0066	4.6	5.7	4.3	0.15	6.48	2.31	2.06	Q ok
P-03	DI-03	MH-04	4989	1312	6301	0.14	0.99	0.14	0.40	6.0	6.48	8.32	3.36	15	46	0.012	0.002309	0.0065	4.6	5.7	4.8	0.16	6.64	1.96	1.66	Q ok
P-04	MH-04	DI-05	1	0	1	0.00	1.00	0.00	0.88	6.0	6.64	8.28	7.26	18	46	0.012	0.004073	0.0065	5.2	9.2	5.8	0.13	6.77	1.56	1.26	Q ok
P-05	DI-05	DI-06	3831	995	4826	0.11	0.99	0.11	0.99	6.0	6.77	8.21	8.10	24	73	0.012	0.001092	0.0064	6.3	19.7	5.8	0.21	6.98	1.16	0.69	Q ok
P-06	DI-06	MH-17	5161	592	5753	0.13	1.00	0.13	1.65	6.0	6.98	8.14	13.46	24	30	0.012	0.003018	0.0067	6.4	20.0	6.8	0.07	7.05	0.59	0.39	Q ok
P-17	MH-17	MH-35	1	0	1	0.00	1.00	0.00	3.04	6.0	7.05	8.10	24.59	*36*	115	0.012	0.001158	0.0030	5.6	39.9	5.9	0.32	7.38	0.29	-0.06	Q ok
Check P-17 for Sanitary Crossing for Conflict																										Check P-1
P-08	DI-08	MH-07	1526	0	1526	0.04	1.00	0.04	0.04	6.0	0.00	8.51	0.30	15	58	0.012	0.000018	0.0066	4.6	5.7	2.3	0.43	6.43	1.36	0.98	Q ok
P-07	MH-07	DI-06	1	0	1	0.00	1.00	0.00	0.54	6.0	0.00	8.51	4.56	18	14	0.012	0.001609	0.0064	5.2	9.1	5.1	0.05	6.05	0.88	0.79	Q ok
P-09	B9/J	MH-04	20585	0	20585	0.47	1.00	0.47	0.47	6.0	0.00	8.51	4.02	18	17	0.012	0.001248	0.0053	4.7	8.3	4.6	0.06	6.06	1.75	1.66	Q ok
P-10	B9/J	MH-07	21845	0	21845	0.50	1.00	0.50	0.50	6.0	0.00	8.51	4.27	18	17	0.012	0.001406	0.0053	4.7	8.3	4.6	0.06	6.06	1.07	0.98	Q ok
P-20	TD-05	DI-21	5394	0	5394	0.12	1.00	0.12	0.12	6.0	0.00	8.51	1.05	8	39	0.011	0.005442	0.0500	9.1	3.2	8.2	0.08	6.08	8.50	6.55	Q ok
P-21	DI-21	MH-22	6185	3410	9595	0.22	0.85	0.19	0.31	6.0	6.08	8.47	2.63	15	31	0.012	0.001409	0.0200	8.1	9.9	6.6	0.08	6.16	4.54	3.92	Q ok
P-22	MH-22	MH-23	1	0	1	0.00	1.00	0.00	0.51	6.0	6.16	8.43	4.28	18	42	0.012	0.001414	0.0200	9.1	16.1	7.5	0.09	6.25	3.72	2.88	Q ok
P-23	MH-23	MH-24	1	0	1	0.00	1.00	0.00	1.33	6.0	6.25	8.40	11.16	18	66	0.012	0.009610	0.0200	9.1	16.1	9.9	0.11	6.36	2.68	1.36	Q ok
P-24	MH-24	MH-35	1	0	1	0.00	1.00	0.00	1.53	6.0	6.36	8.36	12.79	18	56	0.012	0.012638	0.0200	9.1	16.1	10.2	0.09	6.45	1.16	0.04	Q ok
P-25	DI-25	MH-22	6504	3883	10387	0.24	0.83	0.20	0.20	6.0	0.00	8.51	1.68	15	31	0.012	0.000576	0.0200	8.1	9.9	5.6	0.09	6.09	4.54	3.92	Q ok
P-26	B8/K	MH-23	16317	0	16317	0.37	1.00	0.37	0.37	6.0	0.00	8.51	3.19	18	56	0.012	0.000784	0.0050	4.6	8.0	4.2	0.22	6.22	3.06	2.78	Q ok
P-27	B6 South	MH-23	19451	0	19451	0.45	1.00	0.45	0.45	6.0	0.00	8.51	3.80	18	56	0.012	0.001115	0.0050	4.6	8.0	4.4	0.21	6.21	3.06	2.78	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 2	of 5
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000	
Segment:	Central Green Outfall	Storm Frequency: 500	-year (50-year for sumps)		

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-28	DI-28	MH-24	3596	533	4129	0.09	1.00	0.09	0.09	6.0	0.00	8.51	0.81	18	34	0.012	0.000050	0.0200	9.1	16.1	4.5	0.13	6.13	2.04	1.36	Q ok
P-29	DI-29	MH-24	4110	551	4661	0.11	1.00	0.11	0.11	6.0	0.00	8.51	0.91	18	34	0.012	0.000064	0.0200	9.1	16.1	4.5	0.13	6.13	2.04	1.36	Q ok

KEY	
	Upsized from Semi-Final Design to have capacity for 50-yr design storm
	Optional Upsize-50-yr design storm results in >85% Full
	No Change from Semi-Final Design

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 2 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)	

Location: No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-41	MH-41	MH-42	1.60	7.81	7.81	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	8.00	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	7.69	7.69	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	7.81	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	7.51	7.51	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	7.69	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	7.28	7.28	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	7.51	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	7.03	7.03	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	7.28	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	6.80	6.80	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	7.03	8.54	HGL ok
P-47	DI-47	MH-60	2.40	6.34	6.34	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	6.80	9.09	HGL ok
P-60	MH-60	MH-61	2.40	6.03	6.03	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	6.34	9.84	HGL ok
P-61	MH-61	DI-62	2.40	5.65	5.65	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	6.03	11.03	HGL ok
P-62	DI-62	DI-63	2.40	5.30	5.30	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	5.65	10.34	HGL ok
P-63	DI-63	DI-77	1.93	4.75	4.75	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	5.30	10.08	HGL ok
P-77	DI-77	DI-85	3.20	4.15	4.15	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	4.75	10.08	HGL ok
P-85	DI-85	MH-86	4.00	3.47	3.47	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	4.15	9.98	HGL ok
P-86	MH-86	MH-87	4.00	3.31	3.31	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	3.47	10.50	HGL ok
P-87	**MH-87**	**OUTFALL**	**4.00**	**3.20**	**3.20**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**3.31**	**10.50**	**HGL ok**
P-48	MSS MH-08	MH-49	1.60	7.81	7.81	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	7.93	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	7.03	7.03	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	7.13	10.00	HGL ok
P-65	B7 West	MH-64	1.20	5.48	5.48	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	5.56	10.00	HGL ok
P-64	MH-64	DI-63	1.20	5.30	5.30	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	5.48	10.14	HGL ok
P-51	DI-51	DI-52	1.00	6.92	6.92	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.93	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	6.88	6.88	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	6.92	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	6.77	6.77	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	6.88	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	6.59	6.59	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	6.77	8.54	HGL ok
P-55	DI-55	MH-60	1.60	6.34	6.34	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	6.59	9.09	HGL ok
P-56	B5 South	MH-54	1.20	6.77	6.77	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	6.86	10.00	HGL ok
P-78	DI-78	DI-79	1.00	6.56	6.56	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.57	11.60	HGL ok
P-79	DI-79	DI-71	1.20	6.55	6.55	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	6.56	11.15	HGL ok
P-71	DI-71	DI-72	1.20	6.49	6.49	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	6.55	11.15	HGL ok
P-72	DI-72	DI-73	1.20	6.43	6.43	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	6.49	10.99	HGL ok
P-73	DI-73	MH-74	1.20	6.37	6.37	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	6.43	10.84	HGL ok
P-74	MH-74	DI-75	1.20	6.11	6.11	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	6.37	11.24	HGL ok
P-75	DI-75	DI-76	1.20	5.49	5.49	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	6.11	10.63	HGL ok
P-76	DI-76	DI-77	1.20	4.75	4.75	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	5.49	10.34	HGL ok
P-70	DI-70	DI-71	1.00	6.55	6.55	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.56	11.60	HGL ok
P-80	DI-80	MH-74	1.20	6.37	6.37	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	6.48	11.00	HGL ok
P-90	DI-90	DI-91	1.00	3.78	3.78	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	3.82	9.20	HGL ok
P-91	DI-91	MH-87	1.20	3.31	3.31	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	3.78	8.33	HGL ok
P-92	B6 North	DI-91	1.20	3.78	3.78	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	3.86	10.00	HGL ok
P-95	TD-04	MH-86	0.80	3.47	8.00	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	8.49	10.50	HGL ok
P-38	DI-38	DI-39	1.00	4.20	4.20	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.21	10.67	HGL ok
P-39	DI-39	DI-40	1.00	4.18	4.18	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	4.20	10.16	HGL ok
P-40	DI-40	DI-85	1.20	4.15	4.15	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	4.18	9.98	HGL ok
P-35	MH-35	DI-36	2.40	5.14	5.14	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	5.84	11.72	HGL ok
P-36	DI-36	DI-37	2.40	4.63	4.63	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	5.14	10.67	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	4.15	4.15	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	4.63	10.16	HGL ok
P-30	DI-30	MH-35	1.20	5.84	5.84	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.84	11.24	HGL ok
P-11	DI-11	DI-12	1.00	7.17	7.17	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.17	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	7.05	7.05	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	7.17	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	6.85	6.85	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	7.05	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	6.68	6.68	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	6.85	8.68	HGL ok
P-15	DI-15	DI-16	1.60	6.44	6.44	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	6.68	9.01	HGL ok
P-16	DI-16	MH-17	1.60	6.15	6.15	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	6.44	9.77	HGL ok
P-18	B7 South	MH-14	1.20	6.85	6.85	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	6.93	10.00	HGL ok
P-01	DI-01	DI-02	1.00	7.18	7.18	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	7.24	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	7.11	7.11	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	7.18	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	6.94	6.94	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	7.11	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	6.69	6.69	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	6.94	8.60	HGL ok
P-05	DI-05	DI-06	1.60	6.42	6.42	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	6.69	9.01	HGL ok
P-06	DI-06	MH-17	1.60	6.15	6.15	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	6.42	9.87	HGL ok
P-17	MH-17	MH-35	1.60	5.84	5.84	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	6.15	10.61	HGL ok
P-08	DI-08	MH-07	1.00	6.50	6.50	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.50	11.39	HGL ok
P-07	MH-07	DI-06	1.20	6.42	6.42	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	6.50	10.19	HGL ok
P-09	B9/J	MH-04	1.20	6.94	6.94	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	6.97	10.00	HGL ok
P-10	B9/J	MH-07	1.20	6.50	6.50	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	6.53	10.00	HGL ok
P-20	TD-05	DI-21	0.53	7.82	7.82	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	8.06	10.50	HGL ok
P-21	DI-21	MH-22	1.00	7.60	7.60	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	7.82	9.46	HGL ok
P-22	MH-22	MH-23	1.20	7.49	7.49	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	7.60	9.72	HGL ok
P-23	MH-23	MH-24	1.20	6.76	6.76	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	7.49	10.97	HGL ok
P-24	MH-24	MH-35	1.20	5.84	5.84	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	6.76	11.20	HGL ok
P-25	DI-25	MH-22	1.00	7.60	7.60	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	7.62	9.46	HGL ok
P-26	B8/K	MH-23	1.20	7.49	7.49	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	7.54	10.00	HGL ok
P-27	B6 South	MH-23	1.20	7.49	7.49	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	7.56	10.00	HGL ok
P-28	DI-28	MH-24	1.20	6.76	6.76	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.76	10.95	HGL ok
P-29	DI-29	MH-24	1.20	6.76	6.76	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.77	10.95	HGL ok

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: Central Green Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 500 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Cm. No.: 20077

Location No.	Location From	Location To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
			0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-41	MH-41	MH-42	1.60	8.01	8.01	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	8.20	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	7.89	7.89	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	8.01	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	7.71	7.71	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	7.89	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	7.48	7.48	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	7.71	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	7.23	7.23	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	7.48	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	7.00	7.00	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	7.23	8.54	HGL ok
P-47	DI-47	MH-60	2.40	6.54	6.54	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	7.00	9.09	HGL ok
P-60	MH-60	MH-61	2.40	6.23	6.23	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	6.54	9.84	HGL ok
P-61	MH-61	DI-62	2.40	5.85	5.85	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	6.23	11.03	HGL ok
P-62	DI-62	DI-63	2.40	5.50	5.50	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	5.85	10.34	HGL ok
P-63	DI-63	DI-77	1.93	4.95	4.95	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	5.50	10.08	HGL ok
P-77	DI-77	DI-85	3.20	4.35	4.35	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	4.95	10.08	HGL ok
P-85	DI-85	MH-86	4.00	3.67	3.67	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	4.35	9.98	HGL ok
P-86	MH-86	MH-87	4.00	3.51	3.51	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	3.67	10.50	HGL ok
P-87	**MH-87**	**OUTFALL**	**4.00**	**3.40**	**3.40**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**3.51**	**10.50**	**HGL ok**
P-48	MSS MH-08	MH-49	1.60	8.01	8.01	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	8.13	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	7.23	7.23	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	7.33	10.00	HGL ok
P-65	B7 West	MH-64	1.20	5.68	5.68	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	5.76	10.00	HGL ok
P-64	MH-64	DI-63	1.20	5.50	5.50	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	5.68	10.14	HGL ok
P-51	DI-51	DI-52	1.00	7.12	7.12	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.13	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	7.08	7.08	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	7.12	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	6.97	6.97	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	7.08	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	6.79	6.79	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	6.97	8.54	HGL ok
P-55	DI-55	MH-60	1.60	6.54	6.54	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	6.79	9.09	HGL ok
P-56	B5 South	MH-54	1.20	6.97	6.97	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	7.06	10.00	HGL ok
P-78	DI-78	DI-79	1.00	6.76	6.76	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.77	11.60	HGL ok
P-79	DI-79	DI-71	1.20	6.75	6.75	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	6.76	11.15	HGL ok
P-71	DI-71	DI-72	1.20	6.69	6.69	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	6.75	11.15	HGL ok
P-72	DI-72	DI-73	1.20	6.63	6.63	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	6.69	10.99	HGL ok
P-73	DI-73	MH-74	1.20	6.57	6.57	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	6.63	10.84	HGL ok
P-74	MH-74	DI-75	1.20	6.31	6.31	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	6.57	11.24	HGL ok
P-75	DI-75	DI-76	1.20	5.69	5.69	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	6.31	10.63	HGL ok
P-76	DI-76	DI-77	1.20	4.95	4.95	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	5.69	10.34	HGL ok
P-70	DI-70	DI-71	1.00	6.75	6.75	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.76	11.60	HGL ok
P-80	DI-80	MH-74	1.20	6.57	6.57	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	6.68	11.00	HGL ok
P-90	DI-90	DI-91	1.00	3.98	3.98	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	4.02	9.20	HGL ok
P-91	DI-91	MH-87	1.20	3.51	3.51	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	3.98	8.33	HGL ok
P-92	B6 North	DI-91	1.20	3.98	3.98	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	4.06	10.00	HGL ok
P-95	TD-04	MH-86	0.80	3.67	8.00	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	8.49	10.50	HGL ok
P-38	DI-38	DI-39	1.00	4.40	4.40	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.41	10.67	HGL ok
P-39	DI-39	DI-40	1.00	4.38	4.38	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	4.40	10.16	HGL ok
P-40	DI-40	DI-85	1.20	4.35	4.35	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	4.38	9.98	HGL ok
P-35	MH-35	DI-36	2.40	5.34	5.34	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	6.04	11.72	HGL ok
P-36	DI-36	DI-37	2.40	4.83	4.83	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	5.34	10.67	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)		

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*Q*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	4.35	4.35	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	4.83	10.16	HGL ok
P-30	DI-30	MH-35	1.20	6.04	6.04	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.04	11.24	HGL ok
P-11	DI-11	DI-12	1.00	7.37	7.37	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.37	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	7.25	7.25	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	7.37	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	7.05	7.05	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	7.25	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	6.88	6.88	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	7.05	8.68	HGL ok
P-15	DI-15	DI-16	1.60	6.64	6.64	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	6.88	9.01	HGL ok
P-16	DI-16	MH-17	1.60	6.35	6.35	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	6.64	9.77	HGL ok
P-18	B7 South	MH-14	1.20	7.05	7.05	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	7.13	10.00	HGL ok
P-01	DI-01	DI-02	1.00	7.38	7.38	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	7.44	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	7.31	7.31	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	7.38	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	7.14	7.14	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	7.31	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	6.89	6.89	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	7.14	8.60	HGL ok
P-05	DI-05	DI-06	1.60	6.62	6.62	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	6.89	9.01	HGL ok
P-06	DI-06	MH-17	1.60	6.35	6.35	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	6.62	9.87	HGL ok
P-17	MH-17	MH-35	1.60	6.04	6.04	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	6.35	10.61	HGL ok
P-08	DI-08	MH-07	1.00	6.70	6.70	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.70	11.39	HGL ok
P-07	MH-07	DI-06	1.20	6.62	6.62	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	6.70	10.19	HGL ok
P-09	B9/J	MH-04	1.20	7.14	7.14	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	7.17	10.00	HGL ok
P-10	B9/J	MH-07	1.20	6.70	6.70	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	6.73	10.00	HGL ok
P-20	TD-05	DI-21	0.53	8.02	8.02	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	8.26	10.50	HGL ok
P-21	DI-21	MH-22	1.00	7.80	7.80	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	8.02	9.46	HGL ok
P-22	MH-22	MH-23	1.20	7.69	7.69	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	7.80	9.72	HGL ok
P-23	MH-23	MH-24	1.20	6.96	6.96	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	7.69	10.97	HGL ok
P-24	MH-24	MH-35	1.20	6.04	6.04	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	6.96	11.20	HGL ok
P-25	DI-25	MH-22	1.00	7.80	7.80	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	7.82	9.46	HGL ok
P-26	B8/K	MH-23	1.20	7.69	7.69	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	7.74	10.00	HGL ok
P-27	B6 South	MH-23	1.20	7.69	7.69	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	7.76	10.00	HGL ok
P-28	DI-28	MH-24	1.20	6.96	6.96	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.96	10.95	HGL ok
P-29	DI-29	MH-24	1.20	6.96	6.96	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.97	10.95	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/23	Sheet No.: 2 of 5
County:	New Castle	Checked by: TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Central Green Outfall	Design Freq.: 500	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inle WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-41	MH-41	MH-42	1.60	11.51	11.51	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	11.70	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	11.39	11.39	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	11.51	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	11.21	11.21	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	11.39	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	10.98	10.98	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	11.21	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	10.73	10.73	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	10.98	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	10.50	10.50	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	10.73	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	10.04	10.04	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	10.50	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	9.73	9.73	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	10.04	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	9.35	9.35	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	9.73	11.03	HGL ok
P-62	DI-62	DI-63	2.40	9.00	9.00	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	9.35	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	8.45	8.45	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	9.00	10.08	HGL ok
P-77	DI-77	DI-85	3.20	7.85	7.85	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	8.45	10.08	HGL ok
P-85	DI-85	MH-86	4.00	7.17	7.17	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	7.85	9.98	HGL ok
P-86	MH-86	MH-87	4.00	7.01	7.01	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	7.17	10.50	HGL ok
P-87	**MH-87**	**OUTFALL**	**4.00**	**6.90**	**6.90**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**7.01**	**10.50**	**HGL ok**
P-48	MSS MH-08	MH-49	1.60	11.51	11.51	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	11.63	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	10.73	10.73	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	10.83	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	9.18	9.18	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	9.26	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	9.00	9.00	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	9.18	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	10.62	10.62	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.63	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	10.58	10.58	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	10.62	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	10.47	10.47	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	10.58	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	10.29	10.29	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	10.47	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	10.04	10.04	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	10.29	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	10.47	10.47	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	10.56	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	10.26	10.26	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.27	11.60	HGL ok
P-79	DI-79	DI-71	1.20	10.25	10.25	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	10.26	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	10.19	10.19	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	10.25	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	10.13	10.13	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	10.19	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	10.07	10.07	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	10.13	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	9.81	9.81	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	10.07	11.24	HGL ok
P-75	DI-75	DI-76	1.20	9.19	9.19	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	9.81	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	8.45	8.45	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	9.19	10.34	HGL ok
P-70	DI-70	DI-71	1.00	10.25	10.25	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.26	11.60	HGL ok
P-80	DI-80	MH-74	1.20	10.07	10.07	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	10.18	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	7.48	7.48	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	7.52	9.20	HGL ok
P-91	DI-91	MH-87	1.20	7.01	7.01	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	7.48	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	7.48	7.48	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	7.56	10.00	HGL ok
P-95	TD-04	MH-86	0.80	7.17	8.00	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	8.49	10.50	HGL ok
P-38	DI-38	DI-39	1.00	7.90	7.90	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.91	10.67	HGL ok
P-39	DI-39	DI-40	1.00	7.88	7.88	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	7.90	10.16	HGL ok
P-40	DI-40	DI-85	1.20	7.85	7.85	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	7.88	9.98	HGL ok
P-35	MH-35	DI-36	2.40	8.84	8.84	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	9.54	11.72	HGL ok
P-36	DI-36	DI-37	2.40	8.33	8.33	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	8.84	10.67	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	7.85	7.85	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	8.33	10.16	HGL ok
P-30	DI-30	MH-35	1.20	9.54	9.54	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.54	11.24	HGL ok
P-11	DI-11	DI-12	1.00	10.87	10.87	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.87	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	10.75	10.75	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	10.87	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	10.55	10.55	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	10.75	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	10.38	10.38	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	10.55	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	10.14	10.14	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	10.38	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	9.85	9.85	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	10.14	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	10.55	10.55	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	10.63	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	10.88	10.88	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	10.94	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	10.81	10.81	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	10.88	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	10.64	10.64	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	10.81	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	10.39	10.39	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	10.64	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	10.12	10.12	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	10.39	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	9.85	9.85	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	10.12	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	9.54	9.54	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	9.85	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	10.20	10.20	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.20	11.39	HGL ok
P-07	MH-07	DI-06	1.20	10.12	10.12	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	10.20	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	10.64	10.64	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.67	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	10.20	10.20	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	10.23	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	11.52	11.52	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	11.76	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	11.30	11.30	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	11.52	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	11.19	11.19	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	11.30	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	10.46	10.46	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	11.19	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	9.54	9.54	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	10.46	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	11.30	11.30	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.32	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	11.19	11.19	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	11.24	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	11.19	11.19	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	11.26	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	10.46	10.46	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.46	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	10.46	10.46	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.47	10.95	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align; add $Hc = 0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-41	MH-41	MH-42	1.60	12.01	12.01	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	12.20	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	11.89	11.89	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	12.01	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	11.71	11.71	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	11.89	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	11.48	11.48	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	11.71	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	11.23	11.23	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	11.48	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	11.00	11.00	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	11.23	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	10.54	10.54	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	11.00	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	10.23	10.23	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	10.54	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	9.85	9.85	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	10.23	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	9.50	9.50	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	9.85	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	8.95	8.95	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	9.50	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	8.35	8.35	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	8.95	10.08	HGL ok
P-85	DI-85	MH-86	4.00	7.67	7.67	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	8.35	9.98	HGL ok
P-86	MH-86	MH-87	4.00	7.51	7.51	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	7.67	10.50	HGL ok
P-87	**MH-87**	**OUTFALL**	**4.00**	**7.40**	**7.40**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**7.51**	**10.50**	**HGL ok**
P-48	MSS MH-08	MH-49	1.60	12.01	12.01	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	12.13	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	11.23	11.23	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	11.33	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	9.68	9.68	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	9.76	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	9.50	9.50	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	9.68	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	11.12	11.12	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.13	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	11.08	11.08	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	11.12	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	10.97	10.97	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	11.08	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	10.79	10.79	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	10.97	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	10.54	10.54	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	10.79	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	10.97	10.97	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	11.06	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	10.76	10.76	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.77	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	10.75	10.75	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	10.76	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	10.69	10.69	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	10.75	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	10.63	10.63	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	10.69	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	10.57	10.57	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	10.63	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	10.31	10.31	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	10.57	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	9.69	9.69	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	10.31	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	8.95	8.95	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	9.69	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	10.75	10.75	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.76	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	10.57	10.57	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	10.68	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	7.98	7.98	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	8.02	9.20	HGL ok
P-91	DI-91	MH-87	1.20	7.51	7.51	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	7.98	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	7.98	7.98	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	8.06	10.00	HGL ok
P-95	TD-04	MH-86	0.80	7.67	8.00	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	8.49	10.50	HGL ok
P-38	DI-38	DI-39	1.00	8.40	8.40	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.41	10.67	HGL ok
P-39	DI-39	DI-40	1.00	8.38	8.38	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	8.40	10.16	HGL ok
P-40	DI-40	DI-85	1.20	8.35	8.35	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	8.38	9.98	HGL ok
P-35	MH-35	DI-36	2.40	9.34	9.34	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	10.04	11.72	HGL ok
P-36	DI-36	DI-37	2.40	8.83	8.83	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	9.34	10.67	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	8.35	8.35	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	8.83	10.16	HGL ok
P-30	DI-30	MH-35	1.20	10.04	10.04	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.04	11.24	HGL ok
P-11	DI-11	DI-12	1.00	11.37	11.37	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.37	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	11.25	11.25	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	11.37	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	11.05	11.05	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	11.25	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	10.88	10.88	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	11.05	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	10.64	10.64	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	10.88	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	10.35	10.35	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	10.64	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	11.05	11.05	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	11.13	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	11.38	11.38	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	11.44	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	11.31	11.31	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	11.38	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	11.14	11.14	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	11.31	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	10.89	10.89	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	11.14	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	10.62	10.62	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	10.89	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	10.35	10.35	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	10.62	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	10.04	10.04	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	10.35	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	10.70	10.70	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.70	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	10.62	10.62	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	10.70	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	11.14	11.14	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.17	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	10.70	10.70	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	10.73	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	12.02	12.02	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	12.26	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	11.80	11.80	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	12.02	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	11.69	11.69	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	11.80	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	10.96	10.96	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	11.69	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	10.04	10.04	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	10.96	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	11.80	11.80	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.82	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	11.69	11.69	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	11.74	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	11.69	11.69	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	11.76	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	10.96	10.96	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.96	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	10.96	10.96	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.97	10.95	HGL Too High!

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Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 2 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D (ft)	Tailwater, link to Inlet WSE of downstream pipe TW (ft)	Outlet W. S. Elevation HGL Dn (ft)	Outflow Pipe Diameter D_o (in)	Outflow Pipe Design Flow Q_o (cfs)	Pressure-flow Vel., $V_o=Q_o/A$ V_o (fps)	Skew angle vs. Δ_o (deg)	Outflow Pipe Length L (ft)	Friction Slope S_{fo} (ft/ft)	Friction Loss H_f (ft)	Angle of Curvature O (deg)	Curved align; add Hc = $0.002{*}O{*}V_o^2/2g$ H_c (ft)	Contraction Loss H_o (ft)	Q*V for determining controlling inflow pipe Q1V1 (ft^4/s^2)	Q*V for determining controlling inflow pipe Q2V2 (ft^4/s^2)	Q*V for determining controlling inflow pipe Q3V3 (ft^4/s^2)	Controlling Inflow Velocity Vi	Expansion Loss Hi (ft)	Controlling In-flow skew Δ_i (deg)	Bend Loss H_Δ (ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ H_t (cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss $H_{t\,adj}$ (ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ H (ft)	Inlet W. S. Elevation HGL Up (ft)	Top of Grate T/G (ft)	HGL Check
P-41	MH-41	MH-42	1.60	12.41	12.41	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	12.60	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	12.29	12.29	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	12.41	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	12.11	12.11	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	12.29	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	11.88	11.88	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	12.11	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	11.63	11.63	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	11.88	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	11.40	11.40	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	11.63	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	10.94	10.94	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	11.40	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	10.63	10.63	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	10.94	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	10.25	10.25	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	10.63	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	9.90	9.90	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	10.25	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	9.35	9.35	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	9.90	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	8.75	8.75	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	9.35	10.08	HGL Too High!
P-85	DI-85	MH-86	4.00	8.07	8.07	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	8.75	9.98	HGL ok
P-86	MH-86	MH-87	4.00	7.91	7.91	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	8.07	10.50	HGL ok
P-87	**MH-87**	**OUTFALL**	**4.00**	**7.80**	**7.80**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	*0.5*	**0.10**	**0.11**	**7.91**	**10.50**	**HGL ok**
P-48	MSS MH-08	MH-49	1.60	12.41	12.41	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	12.53	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	11.63	11.63	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	11.73	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	10.08	10.08	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	10.16	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	9.90	9.90	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	10.08	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	11.52	11.52	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.53	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	11.48	11.48	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	11.52	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	11.37	11.37	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	11.48	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	11.19	11.19	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	11.37	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	10.94	10.94	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	11.19	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	11.37	11.37	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	11.46	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	11.16	11.16	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.17	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	11.15	11.15	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	11.16	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	11.09	11.09	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	11.15	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	11.03	11.03	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	11.09	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	10.97	10.97	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	11.03	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	10.71	10.71	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	10.97	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	10.09	10.09	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	10.71	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	9.35	9.35	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	10.09	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	11.15	11.15	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.16	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	10.97	10.97	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	11.08	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	8.38	8.38	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	8.42	9.20	HGL Too High!
P-91	DI-91	MH-87	1.20	7.91	7.91	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	8.38	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	8.38	8.38	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	8.46	10.00	HGL ok
P-95	TD-04	MH-86	0.80	8.07	8.07	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	8.56	10.50	HGL ok
P-38	DI-38	DI-39	1.00	8.80	8.80	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.81	10.67	HGL ok
P-39	DI-39	DI-40	1.00	8.78	8.78	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	8.80	10.16	HGL ok
P-40	DI-40	DI-85	1.20	8.75	8.75	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	8.78	9.98	HGL ok
P-35	MH-35	DI-36	2.40	9.74	9.74	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	10.44	11.72	HGL ok
P-36	DI-36	DI-37	2.40	9.23	9.23	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	9.74	10.67	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	8.75	8.75	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	9.23	10.16	HGL Too High!
P-30	DI-30	MH-35	1.20	10.44	10.44	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.44	11.24	HGL Too High!
P-11	DI-11	DI-12	1.00	11.77	11.77	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.77	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	11.65	11.65	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	11.77	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	11.45	11.45	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	11.65	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	11.28	11.28	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	11.45	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	11.04	11.04	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	11.28	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	10.75	10.75	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	11.04	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	11.45	11.45	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	11.53	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	11.78	11.78	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	11.84	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	11.71	11.71	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	11.78	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	11.54	11.54	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	11.71	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	11.29	11.29	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	11.54	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	11.02	11.02	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	11.29	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	10.75	10.75	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	11.02	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	10.44	10.44	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	10.75	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	11.10	11.10	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.10	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	11.02	11.02	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	11.10	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	11.54	11.54	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.57	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	11.10	11.10	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.13	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	12.42	12.42	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	12.66	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	12.20	12.20	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	12.42	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	12.09	12.09	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	12.20	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	11.36	11.36	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	12.09	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	10.44	10.44	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	11.36	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	12.20	12.20	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.22	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	12.09	12.09	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	12.14	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	12.09	12.09	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	12.16	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	11.36	11.36	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.36	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	11.36	11.36	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.37	10.95	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)		

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-41	MH-41	MH-42	1.60	12.91	12.91	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	13.10	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	12.79	12.79	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	12.91	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	12.61	12.61	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	12.79	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	12.38	12.38	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	12.61	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	12.13	12.13	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	12.38	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	11.90	11.90	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	12.13	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	11.44	11.44	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	11.90	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	11.13	11.13	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	11.44	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	10.75	10.75	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	11.13	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	10.40	10.40	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	10.75	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	9.85	9.85	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	10.40	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	9.25	9.25	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	9.85	10.08	HGL Too High!
P-85	DI-85	MH-86	4.00	8.57	8.57	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	9.25	9.98	HGL Too High!
P-86	MH-86	MH-87	4.00	8.41	8.41	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	8.57	10.50	HGL ok
P-87	**MH-87**	**OUTFALL**	**4.00**	**8.30**	**8.30**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**8.41**	**10.50**	**HGL ok**
P-48	MSS MH-08	MH-49	1.60	12.91	12.91	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	13.03	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	12.13	12.13	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	12.23	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	10.58	10.58	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	10.66	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	10.40	10.40	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	10.58	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	12.02	12.02	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.03	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	11.98	11.98	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	12.02	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	11.87	11.87	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	11.98	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	11.69	11.69	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	11.87	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	11.44	11.44	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	11.69	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	11.87	11.87	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	11.96	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	11.66	11.66	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.67	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	11.65	11.65	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	11.66	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	11.59	11.59	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	11.65	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	11.53	11.53	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	11.59	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	11.47	11.47	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	11.53	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	11.21	11.21	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	11.47	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	10.59	10.59	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	11.21	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	9.85	9.85	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	10.59	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	11.65	11.65	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.66	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	11.47	11.47	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	11.58	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	8.88	8.88	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	8.92	9.20	HGL Too High!
P-91	DI-91	MH-87	1.20	8.41	8.41	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	8.88	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	8.88	8.88	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	8.96	10.00	HGL ok
P-95	TD-04	MH-86	0.80	8.57	8.57	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	9.06	10.50	HGL ok
P-38	DI-38	DI-39	1.00	9.30	9.30	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.31	10.67	HGL ok
P-39	DI-39	DI-40	1.00	9.28	9.28	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	9.30	10.16	HGL Too High!
P-40	DI-40	DI-85	1.20	9.25	9.25	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	9.28	9.98	HGL Too High!
P-35	MH-35	DI-36	2.40	10.24	10.24	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	10.94	11.72	HGL Too High!
P-36	DI-36	DI-37	2.40	9.73	9.73	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	10.24	10.67	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	9.25	9.25	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	9.73	10.16	HGL Too High!
P-30	DI-30	MH-35	1.20	10.94	10.94	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.94	11.24	HGL Too High!
P-11	DI-11	DI-12	1.00	12.27	12.27	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.27	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	12.15	12.15	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	12.27	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	11.95	11.95	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	12.15	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	11.78	11.78	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	11.95	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	11.54	11.54	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	11.78	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	11.25	11.25	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	11.54	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	11.95	11.95	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	12.03	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	12.28	12.28	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	12.34	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	12.21	12.21	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	12.28	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	12.04	12.04	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	12.21	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	11.79	11.79	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	12.04	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	11.52	11.52	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	11.79	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	11.25	11.25	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	11.52	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	10.94	10.94	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	11.25	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	11.60	11.60	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.60	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	11.52	11.52	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	11.60	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	12.04	12.04	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.07	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	11.60	11.60	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.63	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	12.92	12.92	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	13.16	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	12.70	12.70	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	12.92	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	12.59	12.59	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	12.70	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	11.86	11.86	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	12.59	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	10.94	10.94	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	11.86	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	12.70	12.70	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.72	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	12.59	12.59	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	12.64	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	12.59	12.59	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	12.66	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	11.86	11.86	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.86	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	11.86	11.86	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.87	10.95	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/23 | Sheet No.: 2 of 5
County: New Castle | Checked by: TMC | Date: 3/23/23 | Cm. No.: 20077
Segment: Central Green Outfall | Design Freq.: 500 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvatu O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss $H_{t\ adj}$ ft	Tot. H Loss, $H = H_f + H_{t\ adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-41	MH-41	MH-42	1.60	13.61	13.61	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	13.80	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	13.49	13.49	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	13.61	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	13.31	13.31	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	13.49	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	13.08	13.08	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	13.31	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	12.83	12.83	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	13.08	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	12.60	12.60	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	12.83	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	12.14	12.14	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	12.60	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	11.83	11.83	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	12.14	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	11.45	11.45	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	11.83	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	11.10	11.10	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	11.45	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	10.55	10.55	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	11.10	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	9.95	9.95	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	10.55	10.08	HGL Too High!
P-85	DI-85	MH-86	4.00	9.27	9.27	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	9.95	9.98	HGL Too High!
P-86	MH-86	MH-87	4.00	9.11	9.11	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	9.27	10.50	HGL ok
P-87	**MH-87**	**OUTFALL**	**4.00**	**9.00**	**9.00**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**9.11**	**10.50**	**HGL ok**
P-48	MSS MH-08	MH-49	1.60	13.61	13.61	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	13.73	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	12.83	12.83	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	12.93	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	11.28	11.28	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	11.36	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	11.10	11.10	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	11.28	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	12.72	12.72	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.73	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	12.68	12.68	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	12.72	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	12.57	12.57	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	12.68	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	12.39	12.39	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	12.57	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	12.14	12.14	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	12.39	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	12.57	12.57	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	12.66	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	12.36	12.36	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.37	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	12.35	12.35	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	12.36	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	12.29	12.29	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	12.35	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	12.23	12.23	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	12.29	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	12.17	12.17	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	12.23	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	11.91	11.91	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	12.17	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	11.29	11.29	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	11.91	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	10.55	10.55	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	11.29	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	12.35	12.35	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.36	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	12.17	12.17	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	12.28	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	9.58	9.58	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	9.62	9.20	HGL Too High!
P-91	DI-91	MH-87	1.20	9.11	9.11	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	9.58	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	9.58	9.58	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	9.66	10.00	HGL Too High!
P-95	TD-04	MH-86	0.80	9.27	9.27	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	9.76	10.50	HGL Too High!
P-38	DI-38	DI-39	1.00	10.00	10.00	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.01	10.67	HGL Too High!
P-39	DI-39	DI-40	1.00	9.98	9.98	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	10.00	10.16	HGL Too High!
P-40	DI-40	DI-85	1.20	9.95	9.95	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	9.98	9.98	HGL Too High!
P-35	MH-35	DI-36	2.40	10.94	10.94	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	11.64	11.72	HGL Too High!
P-36	DI-36	DI-37	2.40	10.43	10.43	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	10.94	10.67	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc = 0.002*Q*V$_o^2$/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	9.95	9.95	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	10.43	10.16	HGL Too High!
P-30	DI-30	MH-35	1.20	11.64	11.64	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.64	11.24	HGL Too High!
P-11	DI-11	DI-12	1.00	12.97	12.97	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.97	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	12.85	12.85	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	12.97	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	12.65	12.65	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	12.85	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	12.48	12.48	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	12.65	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	12.24	12.24	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	12.48	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	11.95	11.95	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	12.24	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	12.65	12.65	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	12.73	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	12.98	12.98	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	13.04	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	12.91	12.91	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	12.98	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	12.74	12.74	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	12.91	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	12.49	12.49	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	12.74	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	12.22	12.22	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	12.49	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	11.95	11.95	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	12.22	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	11.64	11.64	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	11.95	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	12.30	12.30	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.30	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	12.22	12.22	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	12.30	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	12.74	12.74	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.77	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	12.30	12.30	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	12.33	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	13.62	13.62	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	13.86	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	13.40	13.40	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	13.62	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	13.29	13.29	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	13.40	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	12.56	12.56	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	13.29	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	11.64	11.64	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	12.56	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	13.40	13.40	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.42	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	13.29	13.29	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	13.34	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	13.29	13.29	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	13.36	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	12.56	12.56	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.56	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	12.56	12.56	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.57	10.95	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 2 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvature (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\ adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\ adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-41	MH-41	MH-42	1.60	14.11	14.11	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	14.30	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	13.99	13.99	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	14.11	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	13.81	13.81	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	13.99	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	13.58	13.58	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	13.81	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	13.33	13.33	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	13.58	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	13.10	13.10	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	13.33	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	12.64	12.64	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	13.10	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	12.33	12.33	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	12.64	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	11.95	11.95	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	12.33	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	11.60	11.60	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	11.95	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	11.05	11.05	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	11.60	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	10.45	10.45	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	11.05	10.08	HGL Too High!
P-85	DI-85	MH-86	4.00	9.77	9.77	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	10.45	9.98	HGL Too High!
P-86	MH-86	MH-87	4.00	9.61	9.61	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	9.77	10.50	HGL Too High!
P-87	**MH-87**	**OUTFALL**	**4.00**	**9.50**	**9.50**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**9.61**	**10.50**	**HGL Too High!**
P-48	MSS MH-08	MH-49	1.60	14.11	14.11	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	14.23	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	13.33	13.33	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	13.43	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	11.78	11.78	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	11.86	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	11.60	11.60	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	11.78	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	13.22	13.22	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.23	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	13.18	13.18	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	13.22	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	13.07	13.07	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	13.18	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	12.89	12.89	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	13.07	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	12.64	12.64	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	12.89	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	13.07	13.07	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	13.16	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	12.86	12.86	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.87	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	12.85	12.85	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	12.86	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	12.79	12.79	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	12.85	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	12.73	12.73	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	12.79	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	12.67	12.67	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	12.73	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	12.41	12.41	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	12.67	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	11.79	11.79	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	12.41	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	11.05	11.05	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	11.79	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	12.85	12.85	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.86	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	12.67	12.67	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	12.78	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	10.08	10.08	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	10.12	9.20	HGL Too High!
P-91	DI-91	MH-87	1.20	9.61	9.61	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	10.08	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	10.08	10.08	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	10.16	10.00	HGL Too High!
P-95	TD-04	MH-86	0.80	9.77	9.77	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	10.26	10.50	HGL Too High!
P-38	DI-38	DI-39	1.00	10.50	10.50	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.51	10.67	HGL Too High!
P-39	DI-39	DI-40	1.00	10.48	10.48	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	10.50	10.16	HGL Too High!
P-40	DI-40	DI-85	1.20	10.45	10.45	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	10.48	9.98	HGL Too High!
P-35	MH-35	DI-36	2.40	11.44	11.44	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	12.14	11.72	HGL Too High!
P-36	DI-36	DI-37	2.40	10.93	10.93	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	11.44	10.67	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	10.45	10.45	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	10.93	10.16	HGL Too High!
P-30	DI-30	MH-35	1.20	12.14	12.14	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.14	11.24	HGL Too High!
P-11	DI-11	DI-12	1.00	13.47	13.47	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.47	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	13.35	13.35	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	13.47	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	13.15	13.15	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	13.35	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	12.98	12.98	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	13.15	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	12.74	12.74	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	12.98	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	12.45	12.45	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	12.74	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	13.15	13.15	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	13.23	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	13.48	13.48	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	13.54	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	13.41	13.41	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	13.48	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	13.24	13.24	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	13.41	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	12.99	12.99	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	13.24	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	12.72	12.72	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	12.99	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	12.45	12.45	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	12.72	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	12.14	12.14	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	12.45	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	12.80	12.80	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.80	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	12.72	12.72	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	12.80	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	13.24	13.24	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.27	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	12.80	12.80	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	12.83	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	14.12	14.12	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	14.36	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	13.90	13.90	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	14.12	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	13.79	13.79	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	13.90	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	13.06	13.06	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	13.79	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	12.14	12.14	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	13.06	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	13.90	13.90	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.92	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	13.79	13.79	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	13.84	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	13.79	13.79	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	13.86	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	13.06	13.06	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.06	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	13.06	13.06	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.07	10.95	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: Central Green Outfall

Prepared by: SNR   Date: 2/23/23   Sheet No.: 2 of 5
Checked by: TMC   Date: 3/23/23   Cm. No.: 20077
Design Freq.: 500 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvature (O, deg)	Curved align; add $Hc = 0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-41	MH-41	MH-42	1.60	15.41	15.41	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	15.60	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	15.29	15.29	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	15.41	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	15.11	15.11	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	15.29	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	14.88	14.88	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	15.11	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	14.63	14.63	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	14.88	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	14.40	14.40	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	14.63	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	13.94	13.94	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	14.40	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	13.63	13.63	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	13.94	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	13.25	13.25	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	13.63	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	12.90	12.90	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	13.25	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	12.35	12.35	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	12.90	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	11.75	11.75	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	12.35	10.08	HGL Too High!
P-85	DI-85	MH-86	4.00	11.07	11.07	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	11.75	9.98	HGL Too High!
P-86	MH-86	MH-87	4.00	10.91	10.91	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	11.07	10.50	HGL Too High!
P-87	**MH-87**	**OUTFALL**	**4.00**	**10.80**	**10.80**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**10.91**	**10.50**	**HGL Too High!**
P-48	MSS MH-08	MH-49	1.60	15.41	15.41	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	15.53	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	14.63	14.63	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	14.73	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	13.08	13.08	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	13.16	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	12.90	12.90	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	13.08	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	14.52	14.52	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.53	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	14.48	14.48	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	14.52	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	14.37	14.37	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	14.48	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	14.19	14.19	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	14.37	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	13.94	13.94	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	14.19	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	14.37	14.37	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	14.46	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	14.16	14.16	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.17	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	14.15	14.15	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	14.16	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	14.09	14.09	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	14.15	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	14.03	14.03	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	14.09	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	13.97	13.97	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	14.03	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	13.71	13.71	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	13.97	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	13.09	13.09	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	13.71	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	12.35	12.35	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	13.09	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	14.15	14.15	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.16	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	13.97	13.97	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	14.08	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	11.38	11.38	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	11.42	9.20	HGL Too High!
P-91	DI-91	MH-87	1.20	10.91	10.91	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	11.38	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	11.38	11.38	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	11.46	10.00	HGL Too High!
P-95	TD-04	MH-86	0.80	11.07	11.07	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	11.56	10.50	HGL Too High!
P-38	DI-38	DI-39	1.00	11.80	11.80	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.81	10.67	HGL Too High!
P-39	DI-39	DI-40	1.00	11.78	11.78	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	11.80	10.16	HGL Too High!
P-40	DI-40	DI-85	1.20	11.75	11.75	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	11.78	9.98	HGL Too High!
P-35	MH-35	DI-36	2.40	12.74	12.74	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	13.44	11.72	HGL Too High!
P-36	DI-36	DI-37	2.40	12.23	12.23	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	12.74	10.67	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatt	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	11.75	11.75	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	12.23	10.16	HGL Too High!
P-30	DI-30	MH-35	1.20	13.44	13.44	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.44	11.24	HGL Too High!
P-11	DI-11	DI-12	1.00	14.77	14.77	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.77	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	14.65	14.65	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	14.77	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	14.45	14.45	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	14.65	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	14.28	14.28	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	14.45	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	14.04	14.04	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	14.28	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	13.75	13.75	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	14.04	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	14.45	14.45	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	14.53	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	14.78	14.78	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	14.84	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	14.71	14.71	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	14.78	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	14.54	14.54	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	14.71	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	14.29	14.29	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	14.54	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	14.02	14.02	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	14.29	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	13.75	13.75	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	14.02	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	13.44	13.44	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	13.75	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	14.10	14.10	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.10	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	14.02	14.02	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	14.10	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	14.54	14.54	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.57	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	14.10	14.10	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	14.13	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	15.42	15.42	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	15.66	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	15.20	15.20	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	15.42	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	15.09	15.09	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	15.20	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	14.36	14.36	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	15.09	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	13.44	13.44	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	14.36	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	15.20	15.20	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	15.22	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	15.09	15.09	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	15.14	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	15.09	15.09	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	15.16	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	14.36	14.36	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.36	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	14.36	14.36	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.37	10.95	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: Central Green Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 2 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 500 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvature O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss $H_{t\ adj}$ ft	Tot. H Loss, $H=H_f+H_{t\ adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-41	MH-41	MH-42	1.60	10.35	10.35	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	10.54	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	10.23	10.23	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	10.35	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	10.05	10.05	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	10.23	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	9.82	9.82	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	10.05	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	9.57	9.57	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	9.82	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	9.34	9.34	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	9.57	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	8.88	8.88	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	9.34	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	8.57	8.57	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	8.88	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	8.19	8.19	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	8.57	11.03	HGL ok
P-62	DI-62	DI-63	2.40	7.84	7.84	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	8.19	10.34	HGL ok
P-63	DI-63	DI-77	1.93	7.29	7.29	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	7.84	10.08	HGL ok
P-77	DI-77	DI-85	3.20	6.69	6.69	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	7.29	10.08	HGL ok
P-85	DI-85	MH-86	4.00	6.01	6.01	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	6.69	9.98	HGL ok
P-86	MH-86	MH-87	4.00	5.85	5.85	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	6.01	10.50	HGL ok
P-87	**MH-87**	**OUTFALL**	**4.00**	**5.74**	**5.74**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**5.85**	**10.50**	**HGL ok**
P-48	MSS MH-08	MH-49	1.60	10.35	10.35	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	10.47	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	9.57	9.57	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	9.67	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	8.02	8.02	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	8.10	10.00	HGL ok
P-64	MH-64	DI-63	1.20	7.84	7.84	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	8.02	10.14	HGL ok
P-51	DI-51	DI-52	1.00	9.46	9.46	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.47	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	9.42	9.42	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	9.46	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	9.31	9.31	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	9.42	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	9.13	9.13	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	9.31	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	8.88	8.88	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	9.13	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	9.31	9.31	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	9.40	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	9.10	9.10	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.11	11.60	HGL ok
P-79	DI-79	DI-71	1.20	9.09	9.09	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	9.10	11.15	HGL ok
P-71	DI-71	DI-72	1.20	9.03	9.03	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	9.09	11.15	HGL ok
P-72	DI-72	DI-73	1.20	8.97	8.97	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	9.03	10.99	HGL ok
P-73	DI-73	MH-74	1.20	8.91	8.91	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	8.97	10.84	HGL ok
P-74	MH-74	DI-75	1.20	8.65	8.65	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	8.91	11.24	HGL ok
P-75	DI-75	DI-76	1.20	8.03	8.03	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	8.65	10.63	HGL ok
P-76	DI-76	DI-77	1.20	7.29	7.29	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	8.03	10.34	HGL ok
P-70	DI-70	DI-71	1.00	9.09	9.09	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.10	11.60	HGL ok
P-80	DI-80	MH-74	1.20	8.91	8.91	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	9.02	11.00	HGL ok
P-90	DI-90	DI-91	1.00	6.32	6.32	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	6.36	9.20	HGL ok
P-91	DI-91	MH-87	1.20	5.85	5.85	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	6.32	8.33	HGL ok
P-92	B6 North	DI-91	1.20	6.32	6.32	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	6.40	10.00	HGL ok
P-95	TD-04	MH-86	0.80	6.01	8.00	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	8.49	10.50	HGL ok
P-38	DI-38	DI-39	1.00	6.74	6.74	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.75	10.67	HGL ok
P-39	DI-39	DI-40	1.00	6.72	6.72	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	6.74	10.16	HGL ok
P-40	DI-40	DI-85	1.20	6.69	6.69	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	6.72	9.98	HGL ok
P-35	MH-35	DI-36	2.40	7.68	7.68	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	8.38	11.72	HGL ok
P-36	DI-36	DI-37	2.40	7.17	7.17	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	7.68	10.67	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*Q*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	6.69	6.69	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	7.17	10.16	HGL ok
P-30	DI-30	MH-35	1.20	8.38	8.38	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.38	11.24	HGL ok
P-11	DI-11	DI-12	1.00	9.71	9.71	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.71	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	9.59	9.59	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	9.71	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	9.39	9.39	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	9.59	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	9.22	9.22	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	9.39	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	8.98	8.98	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	9.22	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	8.69	8.69	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	8.98	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	9.39	9.39	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	9.47	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	9.72	9.72	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	9.78	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	9.65	9.65	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	9.72	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	9.48	9.48	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	9.65	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	9.23	9.23	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	9.48	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	8.96	8.96	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	9.23	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	8.69	8.69	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	8.96	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	8.38	8.38	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	8.69	10.61	HGL ok
P-08	DI-08	MH-07	1.00	9.04	9.04	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.04	11.39	HGL ok
P-07	MH-07	DI-06	1.20	8.96	8.96	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	9.04	10.19	HGL ok
P-09	B9/J	MH-04	1.20	9.48	9.48	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.51	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	9.04	9.04	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	9.07	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	10.36	10.36	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	10.60	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	10.14	10.14	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	10.36	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	10.03	10.03	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	10.14	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	9.30	9.30	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	10.03	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	8.38	8.38	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	9.30	11.20	HGL ok
P-25	DI-25	MH-22	1.00	10.14	10.14	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.16	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	10.03	10.03	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	10.08	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	10.03	10.03	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	10.10	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	9.30	9.30	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.30	10.95	HGL ok
P-29	DI-29	MH-24	1.20	9.30	9.30	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.31	10.95	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvature O deg	Curved align; add $Hc = 0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss $H_{t\ adj}$ ft	Tot. H Loss, $H = H_f + H_{t\ adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-41	MH-41	MH-42	1.60	10.55	10.55	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	10.74	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	10.43	10.43	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	10.55	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	10.25	10.25	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	10.43	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	10.02	10.02	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	10.25	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	9.77	9.77	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	10.02	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	9.54	9.54	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	9.77	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	9.08	9.08	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	9.54	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	8.77	8.77	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	9.08	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	8.39	8.39	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	8.77	11.03	HGL ok
P-62	DI-62	DI-63	2.40	8.04	8.04	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	8.39	10.34	HGL ok
P-63	DI-63	DI-77	1.93	7.49	7.49	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	8.04	10.08	HGL ok
P-77	DI-77	DI-85	3.20	6.89	6.89	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	7.49	10.08	HGL ok
P-85	DI-85	MH-86	4.00	6.21	6.21	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	6.89	9.98	HGL ok
P-86	MH-86	MH-87	4.00	6.05	6.05	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	6.21	10.50	HGL ok
P-87	**MH-87**	**OUTFALL**	**4.00**	**5.94**	**5.94**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**6.05**	**10.50**	**HGL ok**
P-48	MSS MH-08	MH-49	1.60	10.55	10.55	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	10.67	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	9.77	9.77	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	9.87	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	8.22	8.22	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	8.30	10.00	HGL ok
P-64	MH-64	DI-63	1.20	8.04	8.04	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	8.22	10.14	HGL ok
P-51	DI-51	DI-52	1.00	9.66	9.66	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.67	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	9.62	9.62	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	9.66	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	9.51	9.51	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	9.62	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	9.33	9.33	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	9.51	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	9.08	9.08	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	9.33	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	9.51	9.51	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	9.60	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	9.30	9.30	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.31	11.60	HGL ok
P-79	DI-79	DI-71	1.20	9.29	9.29	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	9.30	11.15	HGL ok
P-71	DI-71	DI-72	1.20	9.23	9.23	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	9.29	11.15	HGL ok
P-72	DI-72	DI-73	1.20	9.17	9.17	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	9.23	10.99	HGL ok
P-73	DI-73	MH-74	1.20	9.11	9.11	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	9.17	10.84	HGL ok
P-74	MH-74	DI-75	1.20	8.85	8.85	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	9.11	11.24	HGL ok
P-75	DI-75	DI-76	1.20	8.23	8.23	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	8.85	10.63	HGL ok
P-76	DI-76	DI-77	1.20	7.49	7.49	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	8.23	10.34	HGL ok
P-70	DI-70	DI-71	1.00	9.29	9.29	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.30	11.60	HGL ok
P-80	DI-80	MH-74	1.20	9.11	9.11	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	9.22	11.00	HGL ok
P-90	DI-90	DI-91	1.00	6.52	6.52	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	6.56	9.20	HGL ok
P-91	DI-91	MH-87	1.20	6.05	6.05	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	6.52	8.33	HGL ok
P-92	B6 North	DI-91	1.20	6.52	6.52	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	6.60	10.00	HGL ok
P-95	TD-04	MH-86	0.80	6.21	8.00	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	8.49	10.50	HGL ok
P-38	DI-38	DI-39	1.00	6.94	6.94	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.95	10.67	HGL ok
P-39	DI-39	DI-40	1.00	6.92	6.92	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	6.94	10.16	HGL ok
P-40	DI-40	DI-85	1.20	6.89	6.89	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	6.92	9.98	HGL ok
P-35	MH-35	DI-36	2.40	7.88	7.88	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	8.58	11.72	HGL ok
P-36	DI-36	DI-37	2.40	7.37	7.37	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	7.88	10.67	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatt	Curved align; add Hc = $0.002*Q*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	6.89	6.89	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	7.37	10.16	HGL ok
P-30	DI-30	MH-35	1.20	8.58	8.58	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.58	11.24	HGL ok
P-11	DI-11	DI-12	1.00	9.91	9.91	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.91	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	9.79	9.79	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	9.91	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	9.59	9.59	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	9.79	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	9.42	9.42	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	9.59	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	9.18	9.18	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	9.42	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	8.89	8.89	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	9.18	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	9.59	9.59	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	9.67	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	9.92	9.92	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	9.98	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	9.85	9.85	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	9.92	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	9.68	9.68	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	9.85	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	9.43	9.43	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	9.68	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	9.16	9.16	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	9.43	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	8.89	8.89	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	9.16	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	8.58	8.58	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	8.89	10.61	HGL ok
P-08	DI-08	MH-07	1.00	9.24	9.24	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.24	11.39	HGL ok
P-07	MH-07	DI-06	1.20	9.16	9.16	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	9.24	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	9.68	9.68	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.71	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	9.24	9.24	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	9.27	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	10.56	10.56	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	10.80	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	10.34	10.34	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	10.56	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	10.23	10.23	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	10.34	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	9.50	9.50	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	10.23	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	8.58	8.58	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	9.50	11.20	HGL ok
P-25	DI-25	MH-22	1.00	10.34	10.34	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.36	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	10.23	10.23	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	10.28	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	10.23	10.23	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	10.30	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	9.50	9.50	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.50	10.95	HGL ok
P-29	DI-29	MH-24	1.20	9.50	9.50	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.51	10.95	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-41	MH-41	MH-42	1.60	14.05	14.05	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	14.24	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	13.93	13.93	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	14.05	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	13.75	13.75	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	13.93	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	13.52	13.52	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	13.75	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	13.27	13.27	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	13.52	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	13.04	13.04	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	13.27	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	12.58	12.58	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	13.04	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	12.27	12.27	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	12.58	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	11.89	11.89	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	12.27	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	11.54	11.54	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	11.89	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	10.99	10.99	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	11.54	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	10.39	10.39	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	10.99	10.08	HGL Too High!
P-85	DI-85	MH-86	4.00	9.71	9.71	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	10.39	9.98	HGL Too High!
P-86	MH-86	MH-87	4.00	9.55	9.55	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	9.71	10.50	HGL Too High!
P-87	**MH-87**	**OUTFALL**	**4.00**	**9.44**	**9.44**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**9.55**	**10.50**	**HGL Too High!**
P-48	MSS MH-08	MH-49	1.60	14.05	14.05	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	14.17	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	13.27	13.27	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	13.37	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	11.72	11.72	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	11.80	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	11.54	11.54	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	11.72	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	13.16	13.16	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.17	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	13.12	13.12	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	13.16	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	13.01	13.01	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	13.12	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	12.83	12.83	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	13.01	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	12.58	12.58	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	12.83	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	13.01	13.01	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	13.10	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	12.80	12.80	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.81	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	12.79	12.79	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	12.80	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	12.73	12.73	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	12.79	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	12.67	12.67	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	12.73	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	12.61	12.61	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	12.67	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	12.35	12.35	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	12.61	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	11.73	11.73	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	12.35	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	10.99	10.99	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	11.73	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	12.79	12.79	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.80	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	12.61	12.61	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	12.72	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	10.02	10.02	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	10.06	9.20	HGL Too High!
P-91	DI-91	MH-87	1.20	9.55	9.55	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	10.02	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	10.02	10.02	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	10.10	10.00	HGL Too High!
P-95	TD-04	MH-86	0.80	9.71	9.71	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	10.20	10.50	HGL Too High!
P-38	DI-38	DI-39	1.00	10.44	10.44	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.45	10.67	HGL Too High!
P-39	DI-39	DI-40	1.00	10.42	10.42	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	10.44	10.16	HGL Too High!
P-40	DI-40	DI-85	1.20	10.39	10.39	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	10.42	9.98	HGL Too High!
P-35	MH-35	DI-36	2.40	11.38	11.38	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	12.08	11.72	HGL Too High!
P-36	DI-36	DI-37	2.40	10.87	10.87	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	11.38	10.67	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	10.39	10.39	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	10.87	10.16	HGL Too High!
P-30	DI-30	MH-35	1.20	12.08	12.08	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.08	11.24	HGL Too High!
P-11	DI-11	DI-12	1.00	13.41	13.41	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.41	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	13.29	13.29	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	13.41	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	13.09	13.09	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	13.29	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	12.92	12.92	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	13.09	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	12.68	12.68	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	12.92	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	12.39	12.39	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	12.68	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	13.09	13.09	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	13.17	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	13.42	13.42	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	13.48	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	13.35	13.35	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	13.42	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	13.18	13.18	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	13.35	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	12.93	12.93	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	13.18	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	12.66	12.66	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	12.93	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	12.39	12.39	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	12.66	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	12.08	12.08	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	12.39	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	12.74	12.74	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.74	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	12.66	12.66	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	12.74	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	13.18	13.18	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.21	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	12.74	12.74	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	12.77	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	14.06	14.06	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	14.30	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	13.84	13.84	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	14.06	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	13.73	13.73	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	13.84	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	13.00	13.00	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	13.73	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	12.08	12.08	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	13.00	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	13.84	13.84	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.86	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	13.73	13.73	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	13.78	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	13.73	13.73	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	13.80	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	13.00	13.00	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.00	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	13.00	13.00	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.01	10.95	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 2 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inle WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvatu O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss $H_{t\ adj}$ ft	Tot. H Loss, $H = H_f + H_{t\ adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-41	MH-41	MH-42	1.60	14.55	14.55	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	14.74	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	14.43	14.43	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	14.55	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	14.25	14.25	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	14.43	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	14.02	14.02	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	14.25	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	13.77	13.77	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	14.02	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	13.54	13.54	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	13.77	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	13.08	13.08	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	13.54	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	12.77	12.77	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	13.08	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	12.39	12.39	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	12.77	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	12.04	12.04	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	12.39	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	11.49	11.49	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	12.04	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	10.89	10.89	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	11.49	10.08	HGL Too High!
P-85	DI-85	MH-86	4.00	10.21	10.21	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	10.89	9.98	HGL Too High!
P-86	MH-86	MH-87	4.00	10.05	10.05	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	10.21	10.50	HGL Too High!
P-87	**MH-87**	**OUTFALL**	**4.00**	**9.94**	**9.94**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**10.05**	**10.50**	**HGL Too High!**
P-48	MSS MH-08	MH-49	1.60	14.55	14.55	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	14.67	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	13.77	13.77	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	13.87	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	12.22	12.22	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	12.30	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	12.04	12.04	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	12.22	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	13.66	13.66	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.67	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	13.62	13.62	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	13.66	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	13.51	13.51	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	13.62	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	13.33	13.33	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	13.51	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	13.08	13.08	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	13.33	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	13.51	13.51	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	13.60	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	13.30	13.30	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.31	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	13.29	13.29	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	13.30	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	13.23	13.23	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	13.29	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	13.17	13.17	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	13.23	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	13.11	13.11	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	13.17	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	12.85	12.85	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	13.11	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	12.23	12.23	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	12.85	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	11.49	11.49	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	12.23	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	13.29	13.29	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.30	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	13.11	13.11	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	13.22	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	10.52	10.52	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	10.56	9.20	HGL Too High!
P-91	DI-91	MH-87	1.20	10.05	10.05	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	10.52	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	10.52	10.52	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	10.60	10.00	HGL Too High!
P-95	TD-04	MH-86	0.80	10.21	10.21	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	10.70	10.50	HGL Too High!
P-38	DI-38	DI-39	1.00	10.94	10.94	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.95	10.67	HGL Too High!
P-39	DI-39	DI-40	1.00	10.92	10.92	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	10.94	10.16	HGL Too High!
P-40	DI-40	DI-85	1.20	10.89	10.89	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	10.92	9.98	HGL Too High!
P-35	MH-35	DI-36	2.40	11.88	11.88	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	12.58	11.72	HGL Too High!
P-36	DI-36	DI-37	2.40	11.37	11.37	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	11.88	10.67	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	10.89	10.89	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	11.37	10.16	HGL Too High!
P-30	DI-30	MH-35	1.20	12.58	12.58	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.58	11.24	HGL Too High!
P-11	DI-11	DI-12	1.00	13.91	13.91	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.91	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	13.79	13.79	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	13.91	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	13.59	13.59	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	13.79	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	13.42	13.42	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	13.59	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	13.18	13.18	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	13.42	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	12.89	12.89	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	13.18	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	13.59	13.59	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	13.67	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	13.92	13.92	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	13.98	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	13.85	13.85	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	13.92	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	13.68	13.68	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	13.85	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	13.43	13.43	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	13.68	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	13.16	13.16	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	13.43	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	12.89	12.89	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	13.16	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	12.58	12.58	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	12.89	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	13.24	13.24	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.24	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	13.16	13.16	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	13.24	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	13.68	13.68	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.71	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	13.24	13.24	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	13.27	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	14.56	14.56	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	14.80	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	14.34	14.34	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	14.56	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	14.23	14.23	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	14.34	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	13.50	13.50	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	14.23	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	12.58	12.58	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	13.50	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	14.34	14.34	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.36	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	14.23	14.23	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	14.28	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	14.23	14.23	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	14.30	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	13.50	13.50	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.50	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	13.50	13.50	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.51	10.95	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)		

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvature O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-41	MH-41	MH-42	1.60	14.95	14.95	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	15.14	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	14.83	14.83	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	14.95	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	14.65	14.65	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	14.83	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	14.42	14.42	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	14.65	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	14.17	14.17	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	14.42	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	13.94	13.94	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	14.17	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	13.48	13.48	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	13.94	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	13.17	13.17	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	13.48	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	12.79	12.79	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	13.17	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	12.44	12.44	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	12.79	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	11.89	11.89	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	12.44	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	11.29	11.29	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	11.89	10.08	HGL Too High!
P-85	DI-85	MH-86	4.00	10.61	10.61	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	11.29	9.98	HGL Too High!
P-86	MH-86	MH-87	4.00	10.45	10.45	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	10.61	10.50	HGL Too High!
P-87	**MH-87**	**OUTFALL**	**4.00**	**10.34**	**10.34**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	0.5	**0.10**	**0.11**	**10.45**	**10.50**	**HGL Too High!**
P-48	MSS MH-08	MH-49	1.60	14.95	14.95	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	15.07	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	14.17	14.17	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	14.27	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	12.62	12.62	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	12.70	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	12.44	12.44	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	12.62	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	14.06	14.06	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.07	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	14.02	14.02	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	*1.3*	1.0	0.01	0.05	14.06	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	13.91	13.91	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.10	14.02	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	13.73	13.73	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	13.91	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	13.48	13.48	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	*1.3*	1.0	0.22	0.25	13.73	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	13.91	13.91	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	14.00	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	13.70	13.70	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.71	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	13.69	13.69	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	*1.3*	1.0	0.01	0.02	13.70	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	13.63	13.63	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	*1.3*	1.0	0.03	0.06	13.69	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	13.57	13.57	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	*1.3*	1.0	0.04	0.06	13.63	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	13.51	13.51	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	13.57	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	13.25	13.25	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	13.51	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	12.63	12.63	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	13.25	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	11.89	11.89	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	12.63	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	13.69	13.69	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.70	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	13.51	13.51	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	13.62	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	10.92	10.92	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	10.96	9.20	HGL Too High!
P-91	DI-91	MH-87	1.20	10.45	10.45	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	*1.3*	1.0	0.18	0.47	10.92	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	10.92	10.92	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	11.00	10.00	HGL Too High!
P-95	TD-04	MH-86	0.80	10.61	10.61	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	11.10	10.50	HGL Too High!
P-38	DI-38	DI-39	1.00	11.34	11.34	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.35	10.67	HGL Too High!
P-39	DI-39	DI-40	1.00	11.32	11.32	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.02	11.34	10.16	HGL Too High!
P-40	DI-40	DI-85	1.20	11.29	11.29	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	*1.3*	1.0	0.02	0.03	11.32	9.98	HGL Too High!
P-35	MH-35	DI-36	2.40	12.28	12.28	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	12.98	11.72	HGL Too High!
P-36	DI-36	DI-37	2.40	11.77	11.77	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	12.28	10.67	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	11.29	11.29	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	11.77	10.16	HGL Too High!
P-30	DI-30	MH-35	1.20	12.98	12.98	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.98	11.24	HGL Too High!
P-11	DI-11	DI-12	1.00	14.31	14.31	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.31	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	14.19	14.19	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	14.31	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	13.99	13.99	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	14.19	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	13.82	13.82	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	13.99	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	13.58	13.58	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	13.82	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	13.29	13.29	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	13.58	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	13.99	13.99	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	14.07	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	14.32	14.32	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	14.38	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	14.25	14.25	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	14.32	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	14.08	14.08	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	14.25	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	13.83	13.83	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	14.08	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	13.56	13.56	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	13.83	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	13.29	13.29	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	13.56	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	12.98	12.98	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	13.29	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	13.64	13.64	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.64	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	13.56	13.56	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	13.64	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	14.08	14.08	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.11	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	13.64	13.64	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	13.67	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	14.96	14.96	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	15.20	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	14.74	14.74	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	14.96	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	14.63	14.63	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	14.74	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	13.90	13.90	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	14.63	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	12.98	12.98	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	13.90	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	14.74	14.74	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.76	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	14.63	14.63	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	14.68	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	14.63	14.63	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	14.70	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	13.90	13.90	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.90	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	13.90	13.90	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.91	10.95	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 2 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-41	MH-41	MH-42	1.60	15.45	15.45	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	15.64	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	15.33	15.33	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	15.45	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	15.15	15.15	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	15.33	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	14.92	14.92	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	15.15	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	14.67	14.67	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	14.92	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	14.44	14.44	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	14.67	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	13.98	13.98	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	14.44	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	13.67	13.67	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	13.98	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	13.29	13.29	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	13.67	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	12.94	12.94	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	13.29	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	12.39	12.39	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	12.94	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	11.79	11.79	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	12.39	10.08	HGL Too High!
P-85	DI-85	MH-86	4.00	11.11	11.11	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	11.79	9.98	HGL Too High!
P-86	MH-86	MH-87	4.00	10.95	10.95	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	11.11	10.50	HGL Too High!
P-87	**MH-87**	**OUTFALL**	**4.00**	**10.84**	**10.84**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**10.95**	**10.50**	**HGL Too High!**
P-48	MSS MH-08	MH-49	1.60	15.45	15.45	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	15.57	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	14.67	14.67	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	14.77	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	13.12	13.12	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	13.20	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	12.94	12.94	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	13.12	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	14.56	14.56	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.57	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	14.52	14.52	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	14.56	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	14.41	14.41	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	14.52	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	14.23	14.23	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	14.41	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	13.98	13.98	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	14.23	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	14.41	14.41	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	14.50	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	14.20	14.20	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.21	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	14.19	14.19	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	14.20	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	14.13	14.13	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	14.19	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	14.07	14.07	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	14.13	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	14.01	14.01	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	14.07	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	13.75	13.75	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	14.01	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	13.13	13.13	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	13.75	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	12.39	12.39	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	13.13	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	14.19	14.19	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.20	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	14.01	14.01	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	14.12	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	11.42	11.42	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	11.46	9.20	HGL Too High!
P-91	DI-91	MH-87	1.20	10.95	10.95	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	11.42	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	11.42	11.42	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	11.50	10.00	HGL Too High!
P-95	TD-04	MH-86	0.80	11.11	11.11	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	11.60	10.50	HGL Too High!
P-38	DI-38	DI-39	1.00	11.84	11.84	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.85	10.67	HGL Too High!
P-39	DI-39	DI-40	1.00	11.82	11.82	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	11.84	10.16	HGL Too High!
P-40	DI-40	DI-85	1.20	11.79	11.79	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	11.82	9.98	HGL Too High!
P-35	MH-35	DI-36	2.40	12.78	12.78	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	13.48	11.72	HGL Too High!
P-36	DI-36	DI-37	2.40	12.27	12.27	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	12.78	10.67	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	11.79	11.79	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	12.27	10.16	HGL Too High!
P-30	DI-30	MH-35	1.20	13.48	13.48	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.48	11.24	HGL Too High!
P-11	DI-11	DI-12	1.00	14.81	14.81	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.81	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	14.69	14.69	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	14.81	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	14.49	14.49	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	14.69	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	14.32	14.32	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	14.49	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	14.08	14.08	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	14.32	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	13.79	13.79	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	14.08	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	14.49	14.49	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	14.57	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	14.82	14.82	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	14.88	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	14.75	14.75	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	14.82	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	14.58	14.58	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	14.75	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	14.33	14.33	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	14.58	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	14.06	14.06	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	14.33	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	13.79	13.79	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	14.06	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	13.48	13.48	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	13.79	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	14.14	14.14	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.14	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	14.06	14.06	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	14.14	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	14.58	14.58	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.61	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	14.14	14.14	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	14.17	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	15.46	15.46	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	15.70	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	15.24	15.24	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	15.46	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	15.13	15.13	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	15.24	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	14.40	14.40	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	15.13	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	13.48	13.48	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	14.40	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	15.24	15.24	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	15.26	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	15.13	15.13	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	15.18	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	15.13	15.13	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	15.20	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	14.40	14.40	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.40	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	14.40	14.40	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.41	10.95	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 2 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvature (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\ adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\ adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-41	MH-41	MH-42	1.60	16.15	16.15	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	16.34	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	16.03	16.03	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	16.15	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	15.85	15.85	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	16.03	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	15.62	15.62	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	15.85	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	15.37	15.37	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	15.62	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	15.14	15.14	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	15.37	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	14.68	14.68	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	15.14	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	14.37	14.37	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	14.68	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	13.99	13.99	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	14.37	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	13.64	13.64	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	13.99	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	13.09	13.09	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	13.64	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	12.49	12.49	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	13.09	10.08	HGL Too High!
P-85	DI-85	MH-86	4.00	11.81	11.81	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	12.49	9.98	HGL Too High!
P-86	MH-86	MH-87	4.00	11.65	11.65	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	11.81	10.50	HGL Too High!
P-87	**MH-87**	**OUTFALL**	**4.00**	**11.54**	**11.54**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	**0.5**	**0.10**	**0.11**	**11.65**	**10.50**	**HGL Too High!**
P-48	MSS MH-08	MH-49	1.60	16.15	16.15	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	16.27	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	15.37	15.37	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	15.47	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	13.82	13.82	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	13.90	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	13.64	13.64	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	13.82	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	15.26	15.26	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.27	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	15.22	15.22	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	15.26	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	15.11	15.11	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	15.22	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	14.93	14.93	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	15.11	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	14.68	14.68	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	14.93	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	15.11	15.11	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	15.20	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	14.90	14.90	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.91	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	14.89	14.89	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	14.90	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	14.83	14.83	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	14.89	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	14.77	14.77	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	14.83	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	14.71	14.71	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	14.77	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	14.45	14.45	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	14.71	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	13.83	13.83	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	14.45	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	13.09	13.09	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	13.83	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	14.89	14.89	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.90	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	14.71	14.71	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	14.82	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	12.12	12.12	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	12.16	9.20	HGL Too High!
P-91	DI-91	MH-87	1.20	11.65	11.65	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	12.12	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	12.12	12.12	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	12.20	10.00	HGL Too High!
P-95	TD-04	MH-86	0.80	11.81	11.81	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	12.30	10.50	HGL Too High!
P-38	DI-38	DI-39	1.00	12.54	12.54	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.55	10.67	HGL Too High!
P-39	DI-39	DI-40	1.00	12.52	12.52	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	12.54	10.16	HGL Too High!
P-40	DI-40	DI-85	1.20	12.49	12.49	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	12.52	9.98	HGL Too High!
P-35	MH-35	DI-36	2.40	13.48	13.48	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	14.18	11.72	HGL Too High!
P-36	DI-36	DI-37	2.40	12.97	12.97	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	13.48	10.67	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	12.49	12.49	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	12.97	10.16	HGL Too High!
P-30	DI-30	MH-35	1.20	14.18	14.18	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.18	11.24	HGL Too High!
P-11	DI-11	DI-12	1.00	15.51	15.51	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.51	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	15.39	15.39	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	15.51	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	15.19	15.19	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	15.39	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	15.02	15.02	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	15.19	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	14.78	14.78	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	15.02	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	14.49	14.49	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	14.78	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	15.19	15.19	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	15.27	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	15.52	15.52	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	15.58	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	15.45	15.45	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	15.52	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	15.28	15.28	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	15.45	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	15.03	15.03	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	15.28	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	14.76	14.76	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	15.03	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	14.49	14.49	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	14.76	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	14.18	14.18	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	14.49	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	14.84	14.84	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.84	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	14.76	14.76	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	14.84	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	15.28	15.28	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	15.31	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	14.84	14.84	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	14.87	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	16.16	16.16	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	16.40	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	15.94	15.94	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	16.16	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	15.83	15.83	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	15.94	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	15.10	15.10	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	15.83	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	14.18	14.18	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	15.10	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	15.94	15.94	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	15.96	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	15.83	15.83	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	15.88	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	15.83	15.83	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	15.90	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	15.10	15.10	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.10	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	15.10	15.10	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.11	10.95	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 2 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inle WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-41	MH-41	MH-42	1.60	16.65	16.65	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	16.84	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	16.53	16.53	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	16.65	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	16.35	16.35	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	16.53	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	16.12	16.12	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	16.35	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	15.87	15.87	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	16.12	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	15.64	15.64	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	15.87	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	15.18	15.18	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	15.64	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	14.87	14.87	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	15.18	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	14.49	14.49	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	14.87	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	14.14	14.14	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	14.49	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	13.59	13.59	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	14.14	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	12.99	12.99	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	13.59	10.08	HGL Too High!
P-85	DI-85	MH-86	4.00	12.31	12.31	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	12.99	9.98	HGL Too High!
P-86	MH-86	MH-87	4.00	12.15	12.15	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	12.31	10.50	HGL Too High!
P-87	**MH-87**	**OUTFALL**	**4.00**	**12.04**	**12.04**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	0.5	**0.10**	**0.11**	**12.15**	**10.50**	**HGL Too High!**
P-48	MSS MH-08	MH-49	1.60	16.65	16.65	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	16.77	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	15.87	15.87	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	15.97	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	14.32	14.32	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	14.40	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	14.14	14.14	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	14.32	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	15.76	15.76	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.77	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	15.72	15.72	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	15.76	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	15.61	15.61	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	15.72	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	15.43	15.43	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	15.61	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	15.18	15.18	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	15.43	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	15.61	15.61	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	15.70	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	15.40	15.40	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.41	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	15.39	15.39	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	15.40	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	15.33	15.33	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	15.39	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	15.27	15.27	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	15.33	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	15.21	15.21	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	15.27	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	14.95	14.95	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	15.21	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	14.33	14.33	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	14.95	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	13.59	13.59	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	14.33	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	15.39	15.39	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.40	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	15.21	15.21	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	15.32	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	12.62	12.62	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	12.66	9.20	HGL Too High!
P-91	DI-91	MH-87	1.20	12.15	12.15	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	12.62	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	12.62	12.62	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	12.70	10.00	HGL Too High!
P-95	TD-04	MH-86	0.80	12.31	12.31	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	12.80	10.50	HGL Too High!
P-38	DI-38	DI-39	1.00	13.04	13.04	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.05	10.67	HGL Too High!
P-39	DI-39	DI-40	1.00	13.02	13.02	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	13.04	10.16	HGL Too High!
P-40	DI-40	DI-85	1.20	12.99	12.99	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	13.02	9.98	HGL Too High!
P-35	MH-35	DI-36	2.40	13.98	13.98	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	14.68	11.72	HGL Too High!
P-36	DI-36	DI-37	2.40	13.47	13.47	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	13.98	10.67	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatt	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	12.99	12.99	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	13.47	10.16	HGL Too High!
P-30	DI-30	MH-35	1.20	14.68	14.68	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.68	11.24	HGL Too High!
P-11	DI-11	DI-12	1.00	16.01	16.01	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.01	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	15.89	15.89	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	16.01	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	15.69	15.69	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	15.89	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	15.52	15.52	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	15.69	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	15.28	15.28	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	15.52	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	14.99	14.99	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	15.28	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	15.69	15.69	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	15.77	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	16.02	16.02	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	16.08	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	15.95	15.95	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	16.02	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	15.78	15.78	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	15.95	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	15.53	15.53	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	15.78	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	15.26	15.26	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	15.53	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	14.99	14.99	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	15.26	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	14.68	14.68	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	14.99	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	15.34	15.34	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.34	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	15.26	15.26	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	15.34	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	15.78	15.78	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	15.81	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	15.34	15.34	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	15.37	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	16.66	16.66	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	16.90	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	16.44	16.44	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	16.66	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	16.33	16.33	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	16.44	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	15.60	15.60	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	16.33	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	14.68	14.68	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	15.60	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	16.44	16.44	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	16.46	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	16.33	16.33	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	16.38	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	16.33	16.33	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	16.40	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	15.60	15.60	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.60	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	15.60	15.60	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.61	10.95	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: Central Green Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 2 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 500 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-41	MH-41	MH-42	1.60	17.95	17.95	24	8.5	2.7	69	92	0.0012	0.11	0	0.00	0.03	23.5	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.08	0.19	18.14	7.00	HGL Too High!
P-42	MH-42	DI-43	2.00	17.83	17.83	30	16.5	3.4	13	30	0.0014	0.04	0	0.00	0.04	23.3	23.0	0.0	2.7	0.0	69	0.07	0.15	1.0	0.5	0.08	0.12	17.95	7.86	HGL Too High!
P-43	DI-43	DI-44	2.00	17.65	17.65	30	17.2	3.5	0	25	0.0015	0.04	0	0.00	0.05	55.7	0.0	0.0	3.4	0.1	13	0.03	0.14	1.0	1.0	0.14	0.18	17.83	7.11	HGL Too High!
P-44	DI-44	DI-45	2.00	17.42	17.42	30	18.0	3.7	6	69	0.0016	0.11	0	0.00	0.05	60.3	0.0	0.0	3.5	0.1	0	0.00	0.12	1.0	1.0	0.12	0.23	17.65	7.03	HGL Too High!
P-45	DI-45	MH-46	2.00	17.17	17.17	30	18.7	3.8	13	52	0.0018	0.09	0	0.00	0.06	66.2	0.0	0.0	3.7	0.1	6	0.02	0.15	1.0	1.0	0.15	0.24	17.42	7.59	HGL Too High!
P-46	MH-46	DI-47	2.00	16.94	16.94	30	24.1	4.9	83	42	0.0030	0.12	0	0.00	0.09	71.4	22.2	0.0	3.8	0.1	13	0.04	0.22	1.0	0.5	0.11	0.23	17.17	8.54	HGL Too High!
P-47	DI-47	MH-60	2.40	16.48	16.48	36	24.7	3.5	90	23	0.0012	0.03	0	0.00	0.05	118.8	0.0	0.0	4.9	0.1	83	0.26	0.43	1.0	1.0	0.43	0.46	16.94	9.09	HGL Too High!
P-60	MH-60	MH-61	2.40	16.17	16.17	36	33.7	4.8	82	75	0.0022	0.16	0	0.00	0.09	86.5	31.5	0.0	3.5	0.1	90	0.13	0.29	1.0	0.5	0.14	0.31	16.48	9.84	HGL Too High!
P-61	MH-61	DI-62	2.40	15.79	15.79	36	33.4	4.7	7	76	0.0021	0.16	0	0.00	0.09	161.0	0.0	0.0	4.8	0.1	82	0.23	0.44	1.0	0.5	0.22	0.38	16.17	11.03	HGL Too High!
P-62	DI-62	DI-63	2.40	15.44	15.44	36	33.3	4.7	89	50	0.0021	0.11	0	0.00	0.09	157.7	0.0	0.0	4.7	0.1	7	0.03	0.24	1.0	1.0	0.24	0.35	15.79	10.34	HGL Too High!
P-63	DI-63	DI-77	1.93	14.89	14.89	36	38.8	5.5	92	25	0.0029	0.07	0	0.00	0.12	156.9	22.2	0.0	4.7	0.1	89	0.24	0.48	1.0	1.0	0.48	0.55	15.44	10.08	HGL Too High!
P-77	DI-77	DI-85	3.20	14.29	14.29	48	47.8	3.8	91	50	0.0009	0.05	0	0.00	0.06	213.4	57.5	0.0	5.5	0.2	92	0.33	0.55	1.0	1.0	0.55	0.60	14.89	10.08	HGL Too High!
P-85	DI-85	MH-86	4.00	13.61	13.61	60	84.2	4.3	17	186	0.0009	0.17	0	0.00	0.07	182.2	2.2	194.9	5.3	0.1	90	0.30	0.52	1.0	1.0	0.52	0.69	14.29	9.98	HGL Too High!
P-86	MH-86	MH-87	4.00	13.45	13.45	60	87.7	4.5	0	45	0.0010	0.04	0	0.00	0.08	360.7	51.5	0.0	4.3	0.1	17	0.05	0.23	1.0	0.5	0.12	0.16	13.61	10.50	HGL Too High!
P-87	**MH-87**	**OUTFALL**	**4.00**	**13.34**	**13.34**	**60**	**93.1**	**4.7**	**0**	**9**	**0.0011**	**0.01**	**0**	**0.00**	**0.09**	**391.3**	**26.7**	**0.0**	**4.5**	**0.1**	**0**	**0.00**	**0.20**	**1.0**	0.5	**0.10**	**0.11**	**13.45**	**10.50**	**HGL Too High!**
P-48	MSS MH-08	MH-49	1.60	17.95	17.95	24	8.5	2.7	51.7	64	0.0012	0.08	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.12	18.07	8.07	HGL Too High!
P-50	B7 North	1.00	1.20	17.17	17.17	18	6.3	3.5	83	16	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.10	17.27	10.00	HGL Too High!
P-65	B7 West	MH-64	1.20	15.62	15.62	18	6.3	3.6	75	17	0.0031	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	15.70	10.00	HGL Too High!
P-64	MH-64	DI-63	1.20	15.44	15.44	18	6.3	3.5	74	20	0.0030	0.06	0	0.00	0.05	22.4	0.0	0.0	3.6	0.1	75	0.13	0.24	1.0	0.5	0.12	0.18	15.62	10.14	HGL Too High!
P-51	DI-51	DI-52	1.00	17.06	17.06	15	0.6	0.5	1	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.07	7.11	HGL Too High!
P-52	DI-52	DI-53	1.00	17.02	17.02	15	1.6	1.3	7	69	0.0005	0.04	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	1	0.00	0.01	1.3	1.0	0.01	0.05	17.06	7.03	HGL Too High!
P-53	DI-53	MH-54	1.00	16.91	16.91	15	2.5	2.1	13	51	0.0013	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	17.02	7.59	HGL Too High!
P-54	MH-54	DI-55	1.60	16.73	16.73	24	8.9	2.8	83	41	0.0013	0.05	0	0.00	0.03	5.3	24.2	0.0	3.7	0.1	83	0.14	0.25	1.0	0.5	0.12	0.18	16.91	8.54	HGL Too High!
P-55	DI-55	MH-60	1.60	16.48	16.48	24	9.9	3.2	90	23	0.0016	0.04	0	0.00	0.04	25.0	0.0	0.0	2.8	0.0	83	0.08	0.17	1.3	1.0	0.22	0.25	16.73	9.09	HGL Too High!
P-56	B5 South	MH-54	1.20	16.91	16.91	18	6.5	3.7	83	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	17.00	10.00	HGL Too High!
P-78	DI-78	DI-79	1.00	16.70	16.70	15	0.8	0.6	89	84	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.71	11.60	HGL Too High!
P-79	DI-79	DI-71	1.20	16.69	16.69	18	1.4	0.8	82	29	0.0002	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	89	0.00	0.01	1.3	1.0	0.01	0.02	16.70	11.15	HGL Too High!
P-71	DI-71	DI-72	1.20	16.63	16.63	18	2.9	1.7	2	42	0.0007	0.03	0	0.00	0.01	1.1	0.5	0.0	0.8	0.0	82	0.01	0.02	1.3	1.0	0.03	0.06	16.69	11.15	HGL Too High!
P-72	DI-72	DI-73	1.20	16.57	16.57	18	3.3	1.9	8	29	0.0008	0.02	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	2	0.00	0.03	1.3	1.0	0.04	0.06	16.63	10.99	HGL Too High!
P-73	DI-73	MH-74	1.20	16.51	16.51	18	3.5	2.0	8	17	0.0009	0.02	0	0.00	0.02	6.2	0.0	0.0	1.9	0.0	8	0.01	0.04	1.0	1.0	0.04	0.06	16.57	10.84	HGL Too High!
P-74	MH-74	DI-75	1.20	16.25	16.25	18	9.3	5.3	5	17	0.0067	0.11	0	0.00	0.11	7.0	20.2	0.0	3.4	0.1	82	0.12	0.29	1.0	0.5	0.14	0.26	16.51	11.24	HGL Too High!
P-75	DI-75	DI-76	1.20	15.63	15.63	18	9.7	5.5	9	43	0.0073	0.31	0	0.00	0.12	49.2	0.0	0.0	5.3	0.2	5	0.04	0.31	1.0	1.0	0.31	0.63	16.25	10.63	HGL Too High!
P-76	DI-76	DI-77	1.20	14.89	14.89	18	10.1	5.7	2	51	0.0078	0.40	0	0.00	0.13	53.6	0.0	0.0	5.5	0.2	9	0.05	0.34	1.0	1.0	0.34	0.74	15.63	10.34	HGL Too High!
P-70	DI-70	DI-71	1.00	16.69	16.69	15	0.8	0.7	7	86	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.70	11.60	HGL Too High!
P-80	DI-80	MH-74	1.20	16.51	16.51	18	6.0	3.4	82	24	0.0028	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	16.62	11.00	HGL Too High!
P-90	DI-90	DI-91	1.00	13.92	13.92	15	1.5	1.2	0	79	0.0004	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	13.96	9.20	HGL Too High!
P-91	DI-91	MH-87	1.20	13.45	13.45	18	6.9	3.9	86	81	0.0036	0.29	0	0.00	0.06	1.8	8.3	0.0	2.2	0.0	90	0.05	0.13	1.3	1.0	0.18	0.47	13.92	8.33	HGL Too High!
P-92	B6 North	DI-91	1.20	13.92	13.92	18	3.8	2.2	90	63	0.0011	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	14.00	10.00	HGL Too High!
P-95	TD-04	MH-86	0.80	13.61	13.61	12	6.4	8.1	90	16	0.0228	0.37	0	0.00	0.25	0.0	0.0	0.0	0.0	0.0	0	0.00	0.25	1.0	0.5	0.13	0.49	14.10	10.50	HGL Too High!
P-38	DI-38	DI-39	1.00	14.34	14.34	15	0.3	0.2	2	99	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.35	10.67	HGL Too High!
P-39	DI-39	DI-40	1.00	14.32	14.32	15	1.1	0.9	89	70	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	14.34	10.16	HGL Too High!
P-40	DI-40	DI-85	1.20	14.29	14.29	18	2.0	1.1	0	26	0.0003	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	89	0.01	0.02	1.3	1.0	0.02	0.03	14.32	9.98	HGL Too High!
P-35	MH-35	DI-36	2.40	15.28	15.28	36	36.7	5.2	2	94	0.0026	0.24	0	0.00	0.10	0.0	85.6	92.6	7.2	0.3	78	0.54	0.93	1.0	0.5	0.46	0.71	15.98	11.72	HGL Too High!
P-36	DI-36	DI-37	2.40	14.77	14.77	36	36.7	5.2	3	98	0.0026	0.25	0	0.00	0.10	190.9	0.0	0.0	5.2	0.1	2	0.00	0.25	1.0	1.0	0.25	0.50	15.28	10.67	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	2 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Central Green Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_t + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-37	DI-37	DI-85	2.40	14.29	14.29	36	37.1	5.3	90	70	0.0026	0.18	0	0.00	0.11	190.8	0.0	0.0	5.2	0.1	3	0.04	0.30	1.0	1.0	0.30	0.48	14.77	10.16	HGL Too High!
P-30	DI-30	MH-35	1.20	15.98	15.98	18	0.3	0.2	4	47	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.98	11.24	HGL Too High!
P-11	DI-11	DI-12	1.00	17.31	17.31	15	1.1	0.9	5	20	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.31	6.84	HGL Too High!
P-12	DI-12	DI-13	1.00	17.19	17.19	15	2.3	1.8	6	92	0.0010	0.10	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	5	0.00	0.02	1.3	1.0	0.02	0.12	17.31	6.99	HGL Too High!
P-13	DI-13	MH-14	1.00	16.99	16.99	15	3.4	2.8	14	54	0.0024	0.13	0	0.00	0.03	4.2	0.0	0.0	1.8	0.0	6	0.01	0.05	1.3	1.0	0.07	0.20	17.19	7.91	HGL Too High!
P-14	MH-14	DI-15	1.60	16.82	16.82	24	9.5	3.0	9	38	0.0015	0.06	0	0.00	0.04	9.4	22.0	0.0	3.5	0.1	82	0.13	0.23	1.0	0.5	0.12	0.17	16.99	8.68	HGL Too High!
P-15	DI-15	DI-16	1.60	16.58	16.58	24	10.3	3.3	91	73	0.0018	0.13	0	0.00	0.04	28.4	0.0	0.0	3.0	0.0	9	0.01	0.11	1.0	1.0	0.11	0.24	16.82	9.01	HGL Too High!
P-16	DI-16	MH-17	1.60	16.29	16.29	24	11.3	3.6	90	31	0.0021	0.07	0	0.00	0.05	34.0	0.0	0.0	3.3	0.1	91	0.12	0.23	1.0	1.0	0.23	0.29	16.58	9.77	HGL Too High!
P-18	B7 South	MH-14	1.20	16.99	16.99	18	6.2	3.5	82	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	17.07	10.00	HGL Too High!
P-01	DI-01	DI-02	1.00	17.32	17.32	15	1.7	1.4	4	77	0.0006	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	17.38	6.84	HGL Too High!
P-02	DI-02	DI-03	1.00	17.25	17.25	15	2.2	1.8	11	38	0.0010	0.04	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	4	0.00	0.03	1.3	1.0	0.03	0.07	17.32	7.35	HGL Too High!
P-03	DI-03	MH-04	1.00	17.08	17.08	15	3.4	2.7	14	46	0.0023	0.11	0	0.00	0.03	3.9	0.0	0.0	1.8	0.0	11	0.00	0.05	1.3	1.0	0.07	0.17	17.25	7.91	HGL Too High!
P-04	MH-04	DI-05	1.20	16.83	16.83	18	7.3	4.1	7	46	0.0041	0.19	0	0.00	0.07	9.2	9.1	0.0	2.7	0.0	14	0.02	0.13	1.0	0.5	0.06	0.25	17.08	8.60	HGL Too High!
P-05	DI-05	DI-06	1.60	16.56	16.56	24	8.1	2.6	90	73	0.0011	0.08	0	0.00	0.03	29.8	0.0	0.0	4.1	0.1	7	0.03	0.14	1.3	1.0	0.19	0.27	16.83	9.01	HGL Too High!
P-06	DI-06	MH-17	1.60	16.29	16.29	24	13.5	4.3	90	30	0.0030	0.09	0	0.00	0.07	20.9	11.8	0.0	2.6	0.0	90	0.07	0.18	1.0	1.0	0.18	0.27	16.56	9.87	HGL Too High!
P-17	MH-17	MH-35	1.60	15.98	15.98	36	24.6	3.5	102	115	0.0012	0.13	0	0.00	0.05	57.7	40.6	0.0	4.3	0.1	90	0.20	0.35	1.0	0.5	0.17	0.31	16.29	10.61	HGL Too High!
P-08	DI-08	MH-07	1.00	16.64	16.64	15	0.3	0.2	13	58	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.64	11.39	HGL Too High!
P-07	MH-07	DI-06	1.20	16.56	16.56	18	4.6	2.6	67	14	0.0016	0.02	0	0.00	0.03	0.1	10.3	0.0	2.4	0.0	67	0.05	0.11	1.0	0.5	0.06	0.08	16.64	10.19	HGL Too High!
P-09	B9/J	MH-04	1.20	17.08	17.08	18	4.0	2.3	83	17	0.0012	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	17.11	10.00	HGL Too High!
P-10	B9/J	MH-07	1.20	16.64	16.64	18	4.3	2.4	67	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	16.67	10.00	HGL Too High!
P-20	TD-05	DI-21	0.53	17.96	17.96	8	1.1	3.0	47	39	0.0054	0.21	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.25	18.20	10.50	HGL Too High!
P-21	DI-21	MH-22	1.00	17.74	17.74	15	2.6	2.1	90	31	0.0014	0.04	0	0.00	0.02	3.2	0.0	0.0	3.0	0.0	47	0.07	0.13	1.3	1.0	0.17	0.22	17.96	9.46	HGL Too High!
P-22	MH-22	MH-23	1.20	17.63	17.63	18	4.3	2.4	0	42	0.0014	0.06	0	0.00	0.02	5.6	2.3	0.0	2.1	0.0	90	0.05	0.10	1.0	0.5	0.05	0.11	17.74	9.72	HGL Too High!
P-23	MH-23	MH-24	1.20	16.90	16.90	18	11.2	6.3	0	66	0.0096	0.63	0	0.00	0.15	10.4	5.7	8.2	2.4	0.0	0	0.00	0.19	1.0	0.5	0.09	0.73	17.63	10.97	HGL Too High!
P-24	MH-24	MH-35	1.20	15.98	15.98	18	12.8	7.2	78	56	0.0126	0.71	0	0.00	0.20	70.4	0.4	0.5	6.3	0.2	0	0.00	0.42	1.0	0.5	0.21	0.92	16.90	11.20	HGL Too High!
P-25	DI-25	MH-22	1.00	17.74	17.74	15	1.7	1.4	90	31	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	17.76	9.46	HGL Too High!
P-26	B8/K	MH-23	1.20	17.63	17.63	18	3.2	1.8	90	56	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	17.68	10.00	HGL Too High!
P-27	B6 South	MH-23	1.20	17.63	17.63	18	3.8	2.1	90	56	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	17.70	10.00	HGL Too High!
P-28	DI-28	MH-24	1.20	16.90	16.90	18	0.8	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.90	10.95	HGL Too High!
P-29	DI-29	MH-24	1.20	16.90	16.90	18	0.9	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.91	10.95	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements Prepared by: SNR Date: 2/23/2023 Sheet No.: ____ of ____
County: New Castle Checked by: TMC Date: 3/23/2023 Cm. No.: 20077
Segment: Market Street (to Central Green Outfall) Storm Frequency: 500 -year (50-year for sumps)

Location			Plan Sheet	Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To		A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
				ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
RELOCATED INLET IN SMR																											
P4	**DI19**	**MH1**	CP-1	2405	0	2405	0.06	1.00	0.06	0.06	6.0	0.00	8.51	0.5	15	27.3	0.012	0.000045	0.005	4.1	5.0	2.5	0.19	6.19	4.49	4.35	Q ok
P5	MH1	MH2	CP-1	1	0	1	0.00	1.00	0.00	0.06	6.0	6.19	8.43	0.5	18	82.7	0.012	0.000017	0.005	4.5	8.0	2.2	0.62	6.81	4.25	3.84	Q ok
P7	MH2	MH3	CP-1	1	0	1	0.00	1.00	0.00	0.06	6.0	6.81	8.21	0.5	18	73.8	0.012	0.000016	0.005	4.6	8.1	2.2	0.55	7.36	3.81	3.44	Q ok
P10	MH3	MH4	CP-2	1	0	1	0.00	1.00	0.00	0.30	6.0	7.36	7.99	2.4	18	53.7	0.012	0.000446	0.005	4.6	8.1	3.9	0.23	7.59	3.34	3.07	Q ok
P13	MH4	MH5	CP-2	1	0	1	0.00	1.00	0.00	0.69	6.0	7.59	7.91	5.5	18	59.3	0.012	0.002333	0.005	4.3	7.7	4.7	0.21	7.80	2.97	2.70	Q ok
P15	MH5	MH41	CP-2	1	0	1	0.00	1.00	0.00	1.10	6.0	7.80	7.84	8.6	*24*	**50.0**	0.012	0.001229	0.020	11.0	34.7	9.0	0.09	7.89	2.60	1.60	Q ok
P9	DI3	MH3	CP-1	4110	3259	7369	0.17	0.76	0.13	0.13	6.0	0.00	8.51	1.1	15	18.3	0.012	0.000245	0.005	4.0	4.9	3.0	0.10	6.10	3.68	3.59	Q ok
P8	DI17	MH3	CP-1	3878	2100	5978	0.14	0.85	0.12	0.12	6.0	0.00	8.51	1.0	15	31.3	0.012	0.000201	0.005	4.2	5.2	3.2	0.17	6.17	3.71	3.54	Q ok
P12	DI4	MH4	CP-1	7109	2561	9670	0.22	0.93	0.21	0.21	6.0	0.00	6.73	1.4	15	20.1	0.012	0.000396	0.005	4.0	4.9	3.4	0.10	6.10	3.48	3.38	Q ok
P11	DI18	MH4	CP-1	6435	2210	8645	0.20	0.94	0.19	0.19	6.0	0.00	6.70	1.3	15	28.4	0.012	0.000320	0.005	4.1	5.1	3.4	0.14	6.14	3.48	3.33	Q ok
P14	DI5	MH5	CP-1	4974	2549	7523	0.17	0.86	0.15	0.15	6.0	0.00	8.51	1.3	15	22.6	0.012	0.000327	0.005	4.0	4.9	3.3	0.11	6.11	3.68	3.57	Q ok
P18	DI6	MH6	CP-1	6937	1863	8800	0.20	0.98	0.20	0.20	6.0	0.00	8.51	1.7	15	38.0	0.012	0.000584	0.005	4.0	4.9	3.6	0.17	6.17	4.57	4.38	Q ok
P16	MH6	MH5	CP-2	1	0	1	0.00	1.00	0.00	0.25	6.0	6.17	8.43	2.1	18	40.0	0.012	0.000350	0.011	6.8	12.1	5.1	0.13	6.30	3.77	3.32	Q ok
RELOCATED INLET IN SMR																											
P17	**DI49**	**MH6**	CP-2	2236	105	2341	0.05	1.00	0.05	0.05	6.0	0.00	8.51	0.5	15	33.0	0.012	0.000043	0.005	4.0	4.9	2.4	0.23	6.23	4.19	4.02	Q ok
P32	DI23	MH12	CP-2	5495	1914	7409	0.17	0.94	0.16	0.16	6.0	0.00	8.51	1.4	15	33.31	0.012	0.0004	0.005	4.1	5.0	3.3	0.17	6.17	3.98	3.81	Q ok
P31	DI9	MH12	CP-2	4483	551	5034	0.12	1.00	0.12	0.12	6.0	0.00	8.51	1.0	15	18.3	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.86	3.77	Q ok
P30	MH12	MH11	CP-2	1	0	1	0.00	1.00	0.00	0.28	6.0	6.17	8.43	2.3	18	50.1	0.012	0.0004	0.005	4.5	8.0	3.9	0.22	6.38	3.67	3.42	Q ok
P27	MH11	MH10	CP-2	1	0	1	0.00	1.00	0.00	0.57	6.0	6.38	8.36	4.7	18	73.2	0.012	0.0017	0.005	4.6	8.1	4.8	0.25	6.64	3.39	3.02	Q ok
P25	MH10	MH9	CP-2	1	0	1	0.00	1.00	0.00	0.65	6.0	6.64	8.28	5.4	24	69.68	0.012	0.0005	0.006	6.3	19.7	5.1	0.23	6.86	2.92	2.47	Q ok
P22	MH9	MH8	CP-2	1	0	1	0.00	1.00	0.00	0.83	6.0	6.86	8.17	6.7	24	108.3	0.012	0.0008	0.005	5.5	17.3	5.1	0.36	7.22	2.47	1.93	Q ok
P-80	DI-80	MH-08		9967	0	9967	0.23	1.00	0.23	0.23	6.0	0.00	8.51	1.9	15	49	0.012	0.0008	0.009	5.5	6.8	4.7	0.17	6.17	4.53	4.07	Q ok
P28	DI22	MH11	CP-1	5555	1955	7510	0.17	0.94	0.16	0.16	6.0	0.00	8.51	1.4	15	30.3	0.012	0.0004	0.005	4.0	4.9	3.4	0.15	6.15	3.64	3.49	Q ok
P29	DI8	MH11	CP-1	5120	570	5690	0.13	1.00	0.13	0.13	6.0	0.00	8.51	1.1	15	18.3	0.012	0.0003	0.005	4.0	4.9	3.3	0.09	6.09	3.64	3.55	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements Prepared by: SNR Date: 2/23/2023 Sheet No.: ____ of ____
County: New Castle Checked by: TMC Date: 3/23/2023 Cm. No.: 20077
Segment: Market Street (to Central Green Outfall) Storm Frequency: 500 -year (50-year for sumps)

Location			Plan Sheet	Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To		A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
				ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P26	DI21	MH10	CP-1	2755	930	3685	0.08	0.94	0.08	0.08	6.0	0.00	8.51	0.7	15	18.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.11	6.11	4.02	3.93	Q ok
P23	DI20	MH9	CP-2	3213	1102	4315	0.10	0.94	0.09	0.09	6.0	0.00	8.51	0.8	15	29.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.17	6.17	4.53	4.38	Q ok
P24	DI7	MH9	CP-2	3164	527	3691	0.08	1.00	0.08	0.08	6.0	0.00	8.51	0.7	15	28.02	0.012	0.0001	0.005	4.0	4.9	2.8	0.17	6.17	4.38	4.24	Q ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	8.35	8.35	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.35	7.41	
P5	MH1	MH2	1.20	8.35	8.35	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	8.35	7.93	HGL Too High!
P7	MH2	MH3	1.20	8.35	8.35	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	8.35	7.65	HGL Too High!
P10	MH3	MH4	1.20	8.31	8.31	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	8.35	7.28	HGL Too High!
P13	MH4	MH5	1.20	8.15	8.15	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	8.31	7.09	HGL Too High!
P15	MH5	MH41	1.60	8.00	8.00	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	8.15	7.40	HGL Too High!
P9	DI3	MH3	1.00	8.35	8.35	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.35	6.62	HGL Too High!
P8	DI17	MH3	1.00	8.35	8.35	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.35	6.96	HGL Too High!
P12	DI4	MH4	1.00	8.31	8.31	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	8.33	6.48	HGL Too High!
P11	DI18	MH4	1.00	8.31	8.31	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.33	6.56	HGL Too High!
P14	DI5	MH5	1.00	8.15	8.15	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.16	6.61	HGL Too High!
P18	DI6	MH6	1.00	8.17	8.17	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	8.20	7.13	HGL Too High!
P16	MH6	MH5	1.20	8.15	8.15	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	8.17	7.55	HGL Too High!
P17	DI49	MH6	1.00	8.17	8.17	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.18	7.08	HGL Too High!
P32	DI23	MH12	1.00	8.24	8.24	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	8.26	7.11	HGL Too High!
P31	DI9	MH12	1.00	8.24	8.24	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.25	7.13	HGL Too High!
P30	MH12	MH11	1.60	8.21	8.21	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	8.24	7.48	HGL Too High!
P27	MH11	MH10	1.60	8.08	8.08	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	8.21	7.21	HGL Too High!
P25	MH10	MH9	1.60	8.03	8.03	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	8.08	7.54	HGL Too High!
P22	MH9	MH8	1.60	7.93	7.93	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	8.03	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	7.93	7.93	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	7.98	7.34	HGL Too High!
P28	DI22	MH11	1.00	8.21	8.21	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	8.23	6.74	HGL Too High!
P29	DI8	MH11	1.00	8.21	8.21	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.22	6.92	HGL Too High!
P26	DI21	MH10	1.00	8.08	8.08	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.08	7.23	HGL Too High!
P23	DI20	MH9	1.00	8.03	8.03	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	8.04	7.38	HGL Too High!
P24	DI7	MH9	1.00	8.03	8.03	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.03	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	8.55	8.55	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.55	7.41	
P5	MH1	MH2	1.20	8.55	8.55	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	8.55	7.93	HGL Too High!
P7	MH2	MH3	1.20	8.55	8.55	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	8.55	7.65	HGL Too High!
P10	MH3	MH4	1.20	8.51	8.51	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	8.55	7.28	HGL Too High!
P13	MH4	MH5	1.20	8.35	8.35	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	8.51	7.09	HGL Too High!
P15	MH5	MH41	1.60	8.20	8.20	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	8.35	7.40	HGL Too High!
P9	DI3	MH3	1.00	8.55	8.55	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.55	6.62	HGL Too High!
P8	DI17	MH3	1.00	8.55	8.55	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.55	6.96	HGL Too High!
P12	DI4	MH4	1.00	8.51	8.51	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	8.53	6.48	HGL Too High!
P11	DI18	MH4	1.00	8.51	8.51	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.53	6.56	HGL Too High!
P14	DI5	MH5	1.00	8.35	8.35	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.36	6.61	HGL Too High!
P18	DI6	MH6	1.00	8.37	8.37	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	8.40	7.13	HGL Too High!
P16	MH6	MH5	1.20	8.35	8.35	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	8.37	7.55	HGL Too High!
P17	DI49	MH6	1.00	8.37	8.37	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.38	7.08	HGL Too High!
P32	DI23	MH12	1.00	8.44	8.44	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	8.46	7.11	HGL Too High!
P31	DI9	MH12	1.00	8.44	8.44	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.45	7.13	HGL Too High!
P30	MH12	MH11	1.60	8.41	8.41	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	8.44	7.48	HGL Too High!
P27	MH11	MH10	1.60	8.28	8.28	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	8.41	7.21	HGL Too High!
P25	MH10	MH9	1.60	8.23	8.23	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	8.28	7.54	HGL Too High!
P22	MH9	MH8	1.60	8.13	8.13	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	8.23	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	8.13	8.13	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	8.18	7.34	HGL Too High!
P28	DI22	MH11	1.00	8.41	8.41	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	8.43	6.74	HGL Too High!
P29	DI8	MH11	1.00	8.41	8.41	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.42	6.92	HGL Too High!
P26	DI21	MH10	1.00	8.28	8.28	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.28	7.23	HGL Too High!
P23	DI20	MH9	1.00	8.23	8.23	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	8.24	7.38	HGL Too High!
P24	DI7	MH9	1.00	8.23	8.23	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.23	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	12.05	12.05	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.05	7.41	
P5	MH1	MH2	1.20	12.05	12.05	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	12.05	7.93	HGL Too High!
P7	MH2	MH3	1.20	12.05	12.05	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	12.05	7.65	HGL Too High!
P10	MH3	MH4	1.20	12.01	12.01	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	12.05	7.28	HGL Too High!
P13	MH4	MH5	1.20	11.85	11.85	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	12.01	7.09	HGL Too High!
P15	MH5	MH41	1.60	11.70	11.70	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	11.85	7.40	HGL Too High!
P9	DI3	MH3	1.00	12.05	12.05	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.05	6.62	HGL Too High!
P8	DI17	MH3	1.00	12.05	12.05	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.05	6.96	HGL Too High!
P12	DI4	MH4	1.00	12.01	12.01	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.03	6.48	HGL Too High!
P11	DI18	MH4	1.00	12.01	12.01	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.03	6.56	HGL Too High!
P14	DI5	MH5	1.00	11.85	11.85	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.86	6.61	HGL Too High!
P18	DI6	MH6	1.00	11.87	11.87	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.90	7.13	HGL Too High!
P16	MH6	MH5	1.20	11.85	11.85	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	11.87	7.55	HGL Too High!
P17	DI49	MH6	1.00	11.87	11.87	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.88	7.08	HGL Too High!
P32	DI23	MH12	1.00	11.94	11.94	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	11.96	7.11	HGL Too High!
P31	DI9	MH12	1.00	11.94	11.94	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.95	7.13	HGL Too High!
P30	MH12	MH11	1.60	11.91	11.91	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	11.94	7.48	HGL Too High!
P27	MH11	MH10	1.60	11.78	11.78	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	11.91	7.21	HGL Too High!
P25	MH10	MH9	1.60	11.73	11.73	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	11.78	7.54	HGL Too High!
P22	MH9	MH8	1.60	11.63	11.63	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	11.73	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	11.63	11.63	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	11.68	7.34	HGL Too High!
P28	DI22	MH11	1.00	11.91	11.91	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	11.93	6.74	HGL Too High!
P29	DI8	MH11	1.00	11.91	11.91	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.92	6.92	HGL Too High!
P26	DI21	MH10	1.00	11.78	11.78	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.78	7.23	HGL Too High!
P23	DI20	MH9	1.00	11.73	11.73	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	11.74	7.38	HGL Too High!
P24	DI7	MH9	1.00	11.73	11.73	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.73	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	12.55	12.55	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.55	7.41	
P5	MH1	MH2	1.20	12.55	12.55	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	12.55	7.93	HGL Too High!
P7	MH2	MH3	1.20	12.55	12.55	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	12.55	7.65	HGL Too High!
P10	MH3	MH4	1.20	12.51	12.51	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	12.55	7.28	HGL Too High!
P13	MH4	MH5	1.20	12.35	12.35	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	12.51	7.09	HGL Too High!
P15	MH5	MH41	1.60	12.20	12.20	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	12.35	7.40	HGL Too High!
P9	DI3	MH3	1.00	12.55	12.55	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.55	6.62	HGL Too High!
P8	DI17	MH3	1.00	12.55	12.55	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.55	6.96	HGL Too High!
P12	DI4	MH4	1.00	12.51	12.51	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.53	6.48	HGL Too High!
P11	DI18	MH4	1.00	12.51	12.51	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.53	6.56	HGL Too High!
P14	DI5	MH5	1.00	12.35	12.35	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.36	6.61	HGL Too High!
P18	DI6	MH6	1.00	12.37	12.37	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.40	7.13	HGL Too High!
P16	MH6	MH5	1.20	12.35	12.35	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	12.37	7.55	HGL Too High!
P17	DI49	MH6	1.00	12.37	12.37	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.38	7.08	HGL Too High!
P32	DI23	MH12	1.00	12.44	12.44	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	12.46	7.11	HGL Too High!
P31	DI9	MH12	1.00	12.44	12.44	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.45	7.13	HGL Too High!
P30	MH12	MH11	1.60	12.41	12.41	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	12.44	7.48	HGL Too High!
P27	MH11	MH10	1.60	12.28	12.28	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	12.41	7.21	HGL Too High!
P25	MH10	MH9	1.60	12.23	12.23	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	12.28	7.54	HGL Too High!
P22	MH9	MH8	1.60	12.13	12.13	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	12.23	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	12.13	12.13	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	12.18	7.34	HGL Too High!
P28	DI22	MH11	1.00	12.41	12.41	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	12.43	6.74	HGL Too High!
P29	DI8	MH11	1.00	12.41	12.41	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.42	6.92	HGL Too High!
P26	DI21	MH10	1.00	12.28	12.28	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.28	7.23	HGL Too High!
P23	DI20	MH9	1.00	12.23	12.23	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	12.24	7.38	HGL Too High!
P24	DI7	MH9	1.00	12.23	12.23	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.23	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	12.95	12.95	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.95	7.41	
P5	MH1	MH2	1.20	12.95	12.95	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	12.95	7.93	HGL Too High!
P7	MH2	MH3	1.20	12.95	12.95	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	12.95	7.65	HGL Too High!
P10	MH3	MH4	1.20	12.91	12.91	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	12.95	7.28	HGL Too High!
P13	MH4	MH5	1.20	12.75	12.75	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	12.91	7.09	HGL Too High!
P15	MH5	MH41	1.60	12.60	12.60	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	12.75	7.40	HGL Too High!
P9	DI3	MH3	1.00	12.95	12.95	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.95	6.62	HGL Too High!
P8	DI17	MH3	1.00	12.95	12.95	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.95	6.96	HGL Too High!
P12	DI4	MH4	1.00	12.91	12.91	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.93	6.48	HGL Too High!
P11	DI18	MH4	1.00	12.91	12.91	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.93	6.56	HGL Too High!
P14	DI5	MH5	1.00	12.75	12.75	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.76	6.61	HGL Too High!
P18	DI6	MH6	1.00	12.77	12.77	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.80	7.13	HGL Too High!
P16	MH6	MH5	1.20	12.75	12.75	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	12.77	7.55	HGL Too High!
P17	DI49	MH6	1.00	12.77	12.77	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.78	7.08	HGL Too High!
P32	DI23	MH12	1.00	12.84	12.84	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	12.86	7.11	HGL Too High!
P31	DI9	MH12	1.00	12.84	12.84	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.85	7.13	HGL Too High!
P30	MH12	MH11	1.60	12.81	12.81	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	12.84	7.48	HGL Too High!
P27	MH11	MH10	1.60	12.68	12.68	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	12.81	7.21	HGL Too High!
P25	MH10	MH9	1.60	12.63	12.63	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	12.68	7.54	HGL Too High!
P22	MH9	MH8	1.60	12.53	12.53	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	12.63	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	12.53	12.53	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	12.58	7.34	HGL Too High!
P28	DI22	MH11	1.00	12.81	12.81	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	12.83	6.74	HGL Too High!
P29	DI8	MH11	1.00	12.81	12.81	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.82	6.92	HGL Too High!
P26	DI21	MH10	1.00	12.68	12.68	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.68	7.23	HGL Too High!
P23	DI20	MH9	1.00	12.63	12.63	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	12.64	7.38	HGL Too High!
P24	DI7	MH9	1.00	12.63	12.63	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.63	7.48	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	13.45	13.45	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.45	7.41	
P5	MH1	MH2	1.20	13.45	13.45	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	13.45	7.93	HGL Too High!
P7	MH2	MH3	1.20	13.45	13.45	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	13.45	7.65	HGL Too High!
P10	MH3	MH4	1.20	13.41	13.41	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	13.45	7.28	HGL Too High!
P13	MH4	MH5	1.20	13.25	13.25	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	13.41	7.09	HGL Too High!
P15	MH5	MH41	1.60	13.10	13.10	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	13.25	7.40	HGL Too High!
P9	DI3	MH3	1.00	13.45	13.45	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.45	6.62	HGL Too High!
P8	DI17	MH3	1.00	13.45	13.45	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.45	6.96	HGL Too High!
P12	DI4	MH4	1.00	13.41	13.41	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	13.43	6.48	HGL Too High!
P11	DI18	MH4	1.00	13.41	13.41	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.43	6.56	HGL Too High!
P14	DI5	MH5	1.00	13.25	13.25	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.26	6.61	HGL Too High!
P18	DI6	MH6	1.00	13.27	13.27	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.30	7.13	HGL Too High!
P16	MH6	MH5	1.20	13.25	13.25	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	13.27	7.55	HGL Too High!
P17	DI49	MH6	1.00	13.27	13.27	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.28	7.08	HGL Too High!
P32	DI23	MH12	1.00	13.34	13.34	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	13.36	7.11	HGL Too High!
P31	DI9	MH12	1.00	13.34	13.34	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.35	7.13	HGL Too High!
P30	MH12	MH11	1.60	13.31	13.31	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	13.34	7.48	HGL Too High!
P27	MH11	MH10	1.60	13.18	13.18	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	13.31	7.21	HGL Too High!
P25	MH10	MH9	1.60	13.13	13.13	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	13.18	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.03	13.03	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	13.13	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	13.03	13.03	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	13.08	7.34	HGL Too High!
P28	DI22	MH11	1.00	13.31	13.31	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	13.33	6.74	HGL Too High!
P29	DI8	MH11	1.00	13.31	13.31	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.32	6.92	HGL Too High!
P26	DI21	MH10	1.00	13.18	13.18	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.18	7.23	HGL Too High!
P23	DI20	MH9	1.00	13.13	13.13	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	13.14	7.38	HGL Too High!
P24	DI7	MH9	1.00	13.13	13.13	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.13	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	___ of ___
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	14.15	14.15	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.15	7.41	
P5	MH1	MH2	1.20	14.15	14.15	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	14.15	7.93	HGL Too High!
P7	MH2	MH3	1.20	14.15	14.15	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.15	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.11	14.11	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	14.15	7.28	HGL Too High!
P13	MH4	MH5	1.20	13.95	13.95	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	14.11	7.09	HGL Too High!
P15	MH5	MH41	1.60	13.80	13.80	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	13.95	7.40	HGL Too High!
P9	DI3	MH3	1.00	14.15	14.15	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.15	6.62	HGL Too High!
P8	DI17	MH3	1.00	14.15	14.15	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.15	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.11	14.11	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	14.13	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.11	14.11	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.13	6.56	HGL Too High!
P14	DI5	MH5	1.00	13.95	13.95	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.96	6.61	HGL Too High!
P18	DI6	MH6	1.00	13.97	13.97	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.00	7.13	HGL Too High!
P16	MH6	MH5	1.20	13.95	13.95	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	13.97	7.55	HGL Too High!
P17	DI49	MH6	1.00	13.97	13.97	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.98	7.08	HGL Too High!
P32	DI23	MH12	1.00	14.04	14.04	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.06	7.11	HGL Too High!
P31	DI9	MH12	1.00	14.04	14.04	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.05	7.13	HGL Too High!
P30	MH12	MH11	1.60	14.01	14.01	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	14.04	7.48	HGL Too High!
P27	MH11	MH10	1.60	13.88	13.88	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	14.01	7.21	HGL Too High!
P25	MH10	MH9	1.60	13.83	13.83	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	13.88	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.73	13.73	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	13.83	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	13.73	13.73	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	13.78	7.34	HGL Too High!
P28	DI22	MH11	1.00	14.01	14.01	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.03	6.74	HGL Too High!
P29	DI8	MH11	1.00	14.01	14.01	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.02	6.92	HGL Too High!
P26	DI21	MH10	1.00	13.88	13.88	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.88	7.23	HGL Too High!
P23	DI20	MH9	1.00	13.83	13.83	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	13.84	7.38	HGL Too High!
P24	DI7	MH9	1.00	13.83	13.83	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.83	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	14.65	14.65	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.65	7.41	
P5	MH1	MH2	1.20	14.65	14.65	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	14.65	7.93	HGL Too High!
P7	MH2	MH3	1.20	14.65	14.65	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.65	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.61	14.61	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	14.65	7.28	HGL Too High!
P13	MH4	MH5	1.20	14.45	14.45	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	14.61	7.09	HGL Too High!
P15	MH5	MH41	1.60	14.30	14.30	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	14.45	7.40	HGL Too High!
P9	DI3	MH3	1.00	14.65	14.65	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.65	6.62	HGL Too High!
P8	DI17	MH3	1.00	14.65	14.65	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.65	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.61	14.61	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	14.63	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.61	14.61	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.63	6.56	HGL Too High!
P14	DI5	MH5	1.00	14.45	14.45	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.46	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.47	14.47	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.50	7.13	HGL Too High!
P16	MH6	MH5	1.20	14.45	14.45	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	14.47	7.55	HGL Too High!
P17	DI49	MH6	1.00	14.47	14.47	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.48	7.08	HGL Too High!
P32	DI23	MH12	1.00	14.54	14.54	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.56	7.11	HGL Too High!
P31	DI9	MH12	1.00	14.54	14.54	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.55	7.13	HGL Too High!
P30	MH12	MH11	1.60	14.51	14.51	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	14.54	7.48	HGL Too High!
P27	MH11	MH10	1.60	14.38	14.38	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	14.51	7.21	HGL Too High!
P25	MH10	MH9	1.60	14.33	14.33	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	14.38	7.54	HGL Too High!
P22	MH9	MH8	1.60	14.23	14.23	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	14.33	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	14.23	14.23	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	14.28	7.34	HGL Too High!
P28	DI22	MH11	1.00	14.51	14.51	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.53	6.74	HGL Too High!
P29	DI8	MH11	1.00	14.51	14.51	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.52	6.92	HGL Too High!
P26	DI21	MH10	1.00	14.38	14.38	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.38	7.23	HGL Too High!
P23	DI20	MH9	1.00	14.33	14.33	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	14.34	7.38	HGL Too High!
P24	DI7	MH9	1.00	14.33	14.33	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.33	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	15.95	15.95	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.95	7.41	
P5	MH1	MH2	1.20	15.95	15.95	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	15.95	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.95	15.95	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	15.95	7.65	HGL Too High!
P10	MH3	MH4	1.20	15.91	15.91	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	15.95	7.28	HGL Too High!
P13	MH4	MH5	1.20	15.75	15.75	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	15.91	7.09	HGL Too High!
P15	MH5	MH41	1.60	15.60	15.60	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	15.75	7.40	HGL Too High!
P9	DI3	MH3	1.00	15.95	15.95	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.95	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.95	15.95	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.95	6.96	HGL Too High!
P12	DI4	MH4	1.00	15.91	15.91	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	15.93	6.48	HGL Too High!
P11	DI18	MH4	1.00	15.91	15.91	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.93	6.56	HGL Too High!
P14	DI5	MH5	1.00	15.75	15.75	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.76	6.61	HGL Too High!
P18	DI6	MH6	1.00	15.77	15.77	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	15.80	7.13	HGL Too High!
P16	MH6	MH5	1.20	15.75	15.75	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	15.77	7.55	HGL Too High!
P17	DI49	MH6	1.00	15.77	15.77	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.78	7.08	HGL Too High!
P32	DI23	MH12	1.00	15.84	15.84	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	15.86	7.11	HGL Too High!
P31	DI9	MH12	1.00	15.84	15.84	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.85	7.13	HGL Too High!
P30	MH12	MH11	1.60	15.81	15.81	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	15.84	7.48	HGL Too High!
P27	MH11	MH10	1.60	15.68	15.68	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	15.81	7.21	HGL Too High!
P25	MH10	MH9	1.60	15.63	15.63	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	15.68	7.54	HGL Too High!
P22	MH9	MH8	1.60	15.53	15.53	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	15.63	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	15.53	15.53	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	15.58	7.34	HGL Too High!
P28	DI22	MH11	1.00	15.81	15.81	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	15.83	6.74	HGL Too High!
P29	DI8	MH11	1.00	15.81	15.81	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.82	6.92	HGL Too High!
P26	DI21	MH10	1.00	15.68	15.68	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.68	7.23	HGL Too High!
P23	DI20	MH9	1.00	15.63	15.63	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	15.64	7.38	HGL Too High!
P24	DI7	MH9	1.00	15.63	15.63	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.63	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	10.89	10.89	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.89	7.41	
P5	MH1	MH2	1.20	10.89	10.89	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	10.89	7.93	HGL Too High!
P7	MH2	MH3	1.20	10.89	10.89	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	10.89	7.65	HGL Too High!
P10	MH3	MH4	1.20	10.85	10.85	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	10.89	7.28	HGL Too High!
P13	MH4	MH5	1.20	10.69	10.69	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	10.85	7.09	HGL Too High!
P15	MH5	MH41	1.60	10.54	10.54	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	10.69	7.40	HGL Too High!
P9	DI3	MH3	1.00	10.89	10.89	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.89	6.62	HGL Too High!
P8	DI17	MH3	1.00	10.89	10.89	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.89	6.96	HGL Too High!
P12	DI4	MH4	1.00	10.85	10.85	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	10.87	6.48	HGL Too High!
P11	DI18	MH4	1.00	10.85	10.85	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.87	6.56	HGL Too High!
P14	DI5	MH5	1.00	10.69	10.69	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.70	6.61	HGL Too High!
P18	DI6	MH6	1.00	10.71	10.71	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.74	7.13	HGL Too High!
P16	MH6	MH5	1.20	10.69	10.69	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	10.71	7.55	HGL Too High!
P17	DI49	MH6	1.00	10.71	10.71	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.72	7.08	HGL Too High!
P32	DI23	MH12	1.00	10.78	10.78	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	10.80	7.11	HGL Too High!
P31	DI9	MH12	1.00	10.78	10.78	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.79	7.13	HGL Too High!
P30	MH12	MH11	1.60	10.75	10.75	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	10.78	7.48	HGL Too High!
P27	MH11	MH10	1.60	10.62	10.62	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	10.75	7.21	HGL Too High!
P25	MH10	MH9	1.60	10.57	10.57	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	10.62	7.54	HGL Too High!
P22	MH9	MH8	1.60	10.47	10.47	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	10.57	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	10.47	10.47	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	10.52	7.34	HGL Too High!
P28	DI22	MH11	1.00	10.75	10.75	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	10.77	6.74	HGL Too High!
P29	DI8	MH11	1.00	10.75	10.75	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.76	6.92	HGL Too High!
P26	DI21	MH10	1.00	10.62	10.62	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.62	7.23	HGL Too High!
P23	DI20	MH9	1.00	10.57	10.57	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	10.58	7.38	HGL Too High!
P24	DI7	MH9	1.00	10.57	10.57	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.57	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI19	MH1	1.00	11.09	11.09	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.09	7.41	
P5	MH1	MH2	1.20	11.09	11.09	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	11.09	7.93	HGL Too High!
P7	MH2	MH3	1.20	11.09	11.09	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	11.09	7.65	HGL Too High!
P10	MH3	MH4	1.20	11.05	11.05	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	11.09	7.28	HGL Too High!
P13	MH4	MH5	1.20	10.89	10.89	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	11.05	7.09	HGL Too High!
P15	MH5	MH41	1.60	10.74	10.74	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	10.89	7.40	HGL Too High!
P9	DI3	MH3	1.00	11.09	11.09	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.09	6.62	HGL Too High!
P8	DI17	MH3	1.00	11.09	11.09	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.09	6.96	HGL Too High!
P12	DI4	MH4	1.00	11.05	11.05	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	11.07	6.48	HGL Too High!
P11	DI18	MH4	1.00	11.05	11.05	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.07	6.56	HGL Too High!
P14	DI5	MH5	1.00	10.89	10.89	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.90	6.61	HGL Too High!
P18	DI6	MH6	1.00	10.91	10.91	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.94	7.13	HGL Too High!
P16	MH6	MH5	1.20	10.89	10.89	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	10.91	7.55	HGL Too High!
P17	DI49	MH6	1.00	10.91	10.91	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.92	7.08	HGL Too High!
P32	DI23	MH12	1.00	10.98	10.98	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	11.00	7.11	HGL Too High!
P31	DI9	MH12	1.00	10.98	10.98	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.99	7.13	HGL Too High!
P30	MH12	MH11	1.60	10.95	10.95	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	10.98	7.48	HGL Too High!
P27	MH11	MH10	1.60	10.82	10.82	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	10.95	7.21	HGL Too High!
P25	MH10	MH9	1.60	10.77	10.77	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	10.82	7.54	HGL Too High!
P22	MH9	MH8	1.60	10.67	10.67	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	10.77	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	10.67	10.67	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	10.72	7.34	HGL Too High!
P28	DI22	MH11	1.00	10.95	10.95	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	10.97	6.74	HGL Too High!
P29	DI8	MH11	1.00	10.95	10.95	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.96	6.92	HGL Too High!
P26	DI21	MH10	1.00	10.82	10.82	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.82	7.23	HGL Too High!
P23	DI20	MH9	1.00	10.77	10.77	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	10.78	7.38	HGL Too High!
P24	DI7	MH9	1.00	10.77	10.77	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.77	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	14.59	14.59	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.59	7.41	
P5	MH1	MH2	1.20	14.59	14.59	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	14.59	7.93	HGL Too High!
P7	MH2	MH3	1.20	14.59	14.59	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.59	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.55	14.55	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	14.59	7.28	HGL Too High!
P13	MH4	MH5	1.20	14.39	14.39	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	14.55	7.09	HGL Too High!
P15	MH5	MH41	1.60	14.24	14.24	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	14.39	7.40	HGL Too High!
P9	DI3	MH3	1.00	14.59	14.59	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.59	6.62	HGL Too High!
P8	DI17	MH3	1.00	14.59	14.59	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.59	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.55	14.55	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	14.57	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.55	14.55	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.57	6.56	HGL Too High!
P14	DI5	MH5	1.00	14.39	14.39	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.40	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.41	14.41	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.44	7.13	HGL Too High!
P16	MH6	MH5	1.20	14.39	14.39	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	14.41	7.55	HGL Too High!
P17	DI49	MH6	1.00	14.41	14.41	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.42	7.08	HGL Too High!
P32	DI23	MH12	1.00	14.48	14.48	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.50	7.11	HGL Too High!
P31	DI9	MH12	1.00	14.48	14.48	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.49	7.13	HGL Too High!
P30	MH12	MH11	1.60	14.45	14.45	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	14.48	7.48	HGL Too High!
P27	MH11	MH10	1.60	14.32	14.32	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	14.45	7.21	HGL Too High!
P25	MH10	MH9	1.60	14.27	14.27	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	14.32	7.54	HGL Too High!
P22	MH9	MH8	1.60	14.17	14.17	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	14.27	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	14.17	14.17	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	14.22	7.34	HGL Too High!
P28	DI22	MH11	1.00	14.45	14.45	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.47	6.74	HGL Too High!
P29	DI8	MH11	1.00	14.45	14.45	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.46	6.92	HGL Too High!
P26	DI21	MH10	1.00	14.32	14.32	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.32	7.23	HGL Too High!
P23	DI20	MH9	1.00	14.27	14.27	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	14.28	7.38	HGL Too High!
P24	DI7	MH9	1.00	14.27	14.27	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.27	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	15.09	15.09	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.09	7.41	
P5	MH1	MH2	1.20	15.09	15.09	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	15.09	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.09	15.09	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	15.09	7.65	HGL Too High!
P10	MH3	MH4	1.20	15.05	15.05	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	15.09	7.28	HGL Too High!
P13	MH4	MH5	1.20	14.89	14.89	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	15.05	7.09	HGL Too High!
P15	MH5	MH41	1.60	14.74	14.74	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	14.89	7.40	HGL Too High!
P9	DI3	MH3	1.00	15.09	15.09	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.09	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.09	15.09	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.09	6.96	HGL Too High!
P12	DI4	MH4	1.00	15.05	15.05	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	15.07	6.48	HGL Too High!
P11	DI18	MH4	1.00	15.05	15.05	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.07	6.56	HGL Too High!
P14	DI5	MH5	1.00	14.89	14.89	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.90	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.91	14.91	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.94	7.13	HGL Too High!
P16	MH6	MH5	1.20	14.89	14.89	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	14.91	7.55	HGL Too High!
P17	DI49	MH6	1.00	14.91	14.91	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.92	7.08	HGL Too High!
P32	DI23	MH12	1.00	14.98	14.98	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	15.00	7.11	HGL Too High!
P31	DI9	MH12	1.00	14.98	14.98	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.99	7.13	HGL Too High!
P30	MH12	MH11	1.60	14.95	14.95	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	14.98	7.48	HGL Too High!
P27	MH11	MH10	1.60	14.82	14.82	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	14.95	7.21	HGL Too High!
P25	MH10	MH9	1.60	14.77	14.77	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	14.82	7.54	HGL Too High!
P22	MH9	MH8	1.60	14.67	14.67	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	14.77	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	14.67	14.67	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	14.72	7.34	HGL Too High!
P28	DI22	MH11	1.00	14.95	14.95	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.97	6.74	HGL Too High!
P29	DI8	MH11	1.00	14.95	14.95	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.96	6.92	HGL Too High!
P26	DI21	MH10	1.00	14.82	14.82	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.82	7.23	HGL Too High!
P23	DI20	MH9	1.00	14.77	14.77	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	14.78	7.38	HGL Too High!
P24	DI7	MH9	1.00	14.77	14.77	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.77	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/23 | Sheet No.: ___ of ___
County: New Castle | Checked by: TMC | Date: 3/23/23 | Cm. No.: 20077
Segment: Market Street (to Central Green Outfall) | Design Freq.: 500 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	15.49	15.49	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.49	7.41	
P5	MH1	MH2	1.20	15.49	15.49	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	15.49	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.49	15.49	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	15.49	7.65	HGL Too High!
P10	MH3	MH4	1.20	15.45	15.45	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	15.49	7.28	HGL Too High!
P13	MH4	MH5	1.20	15.29	15.29	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	15.45	7.09	HGL Too High!
P15	MH5	MH41	1.60	15.14	15.14	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	15.29	7.40	HGL Too High!
P9	DI3	MH3	1.00	15.49	15.49	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.49	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.49	15.49	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.49	6.96	HGL Too High!
P12	DI4	MH4	1.00	15.45	15.45	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	15.47	6.48	HGL Too High!
P11	DI18	MH4	1.00	15.45	15.45	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.47	6.56	HGL Too High!
P14	DI5	MH5	1.00	15.29	15.29	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.30	6.61	HGL Too High!
P18	DI6	MH6	1.00	15.31	15.31	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	15.34	7.13	HGL Too High!
P16	MH6	MH5	1.20	15.29	15.29	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	15.31	7.55	HGL Too High!
P17	DI49	MH6	1.00	15.31	15.31	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.32	7.08	HGL Too High!
P32	DI23	MH12	1.00	15.38	15.38	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	15.40	7.11	HGL Too High!
P31	DI9	MH12	1.00	15.38	15.38	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.39	7.13	HGL Too High!
P30	MH12	MH11	1.60	15.35	15.35	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	15.38	7.48	HGL Too High!
P27	MH11	MH10	1.60	15.22	15.22	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	15.35	7.21	HGL Too High!
P25	MH10	MH9	1.60	15.17	15.17	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	15.22	7.54	HGL Too High!
P22	MH9	MH8	1.60	15.07	15.07	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	15.17	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	15.07	15.07	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	15.12	7.34	HGL Too High!
P28	DI22	MH11	1.00	15.35	15.35	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	15.37	6.74	HGL Too High!
P29	DI8	MH11	1.00	15.35	15.35	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.36	6.92	HGL Too High!
P26	DI21	MH10	1.00	15.22	15.22	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.22	7.23	HGL Too High!
P23	DI20	MH9	1.00	15.17	15.17	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	15.18	7.38	HGL Too High!
P24	DI7	MH9	1.00	15.17	15.17	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.17	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	15.99	15.99	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.99	7.41	
P5	MH1	MH2	1.20	15.99	15.99	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	15.99	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.99	15.99	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	15.99	7.65	HGL Too High!
P10	MH3	MH4	1.20	15.95	15.95	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	15.99	7.28	HGL Too High!
P13	MH4	MH5	1.20	15.79	15.79	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	15.95	7.09	HGL Too High!
P15	MH5	MH41	1.60	15.64	15.64	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	15.79	7.40	HGL Too High!
P9	DI3	MH3	1.00	15.99	15.99	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.99	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.99	15.99	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.99	6.96	HGL Too High!
P12	DI4	MH4	1.00	15.95	15.95	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	15.97	6.48	HGL Too High!
P11	DI18	MH4	1.00	15.95	15.95	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.97	6.56	HGL Too High!
P14	DI5	MH5	1.00	15.79	15.79	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.80	6.61	HGL Too High!
P18	DI6	MH6	1.00	15.81	15.81	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	15.84	7.13	HGL Too High!
P16	MH6	MH5	1.20	15.79	15.79	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	15.81	7.55	HGL Too High!
P17	DI49	MH6	1.00	15.81	15.81	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.82	7.08	HGL Too High!
P32	DI23	MH12	1.00	15.88	15.88	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	15.90	7.11	HGL Too High!
P31	DI9	MH12	1.00	15.88	15.88	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.89	7.13	HGL Too High!
P30	MH12	MH11	1.60	15.85	15.85	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	15.88	7.48	HGL Too High!
P27	MH11	MH10	1.60	15.72	15.72	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	15.85	7.21	HGL Too High!
P25	MH10	MH9	1.60	15.67	15.67	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	15.72	7.54	HGL Too High!
P22	MH9	MH8	1.60	15.57	15.57	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	15.67	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	15.57	15.57	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	15.62	7.34	HGL Too High!
P28	DI22	MH11	1.00	15.85	15.85	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	15.87	6.74	HGL Too High!
P29	DI8	MH11	1.00	15.85	15.85	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.86	6.92	HGL Too High!
P26	DI21	MH10	1.00	15.72	15.72	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.72	7.23	HGL Too High!
P23	DI20	MH9	1.00	15.67	15.67	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	15.68	7.38	HGL Too High!
P24	DI7	MH9	1.00	15.67	15.67	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.67	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	16.69	16.69	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.69	7.41	
P5	MH1	MH2	1.20	16.69	16.69	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	16.69	7.93	HGL Too High!
P7	MH2	MH3	1.20	16.69	16.69	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	16.69	7.65	HGL Too High!
P10	MH3	MH4	1.20	16.65	16.65	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	16.69	7.28	HGL Too High!
P13	MH4	MH5	1.20	16.49	16.49	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	16.65	7.09	HGL Too High!
P15	MH5	MH41	1.60	16.34	16.34	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	16.49	7.40	HGL Too High!
P9	DI3	MH3	1.00	16.69	16.69	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.69	6.62	HGL Too High!
P8	DI17	MH3	1.00	16.69	16.69	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.69	6.96	HGL Too High!
P12	DI4	MH4	1.00	16.65	16.65	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	16.67	6.48	HGL Too High!
P11	DI18	MH4	1.00	16.65	16.65	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.67	6.56	HGL Too High!
P14	DI5	MH5	1.00	16.49	16.49	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.50	6.61	HGL Too High!
P18	DI6	MH6	1.00	16.51	16.51	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	16.54	7.13	HGL Too High!
P16	MH6	MH5	1.20	16.49	16.49	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	16.51	7.55	HGL Too High!
P17	DI49	MH6	1.00	16.51	16.51	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.52	7.08	HGL Too High!
P32	DI23	MH12	1.00	16.58	16.58	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	16.60	7.11	HGL Too High!
P31	DI9	MH12	1.00	16.58	16.58	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.59	7.13	HGL Too High!
P30	MH12	MH11	1.60	16.55	16.55	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	16.58	7.48	HGL Too High!
P27	MH11	MH10	1.60	16.42	16.42	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	16.55	7.21	HGL Too High!
P25	MH10	MH9	1.60	16.37	16.37	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	16.42	7.54	HGL Too High!
P22	MH9	MH8	1.60	16.27	16.27	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	16.37	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	16.27	16.27	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	16.32	7.34	HGL Too High!
P28	DI22	MH11	1.00	16.55	16.55	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	16.57	6.74	HGL Too High!
P29	DI8	MH11	1.00	16.55	16.55	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.56	6.92	HGL Too High!
P26	DI21	MH10	1.00	16.42	16.42	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.42	7.23	HGL Too High!
P23	DI20	MH9	1.00	16.37	16.37	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	16.38	7.38	HGL Too High!
P24	DI7	MH9	1.00	16.37	16.37	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.37	7.48	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	17.19	17.19	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.19	7.41	
P5	MH1	MH2	1.20	17.19	17.19	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	17.19	7.93	HGL Too High!
P7	MH2	MH3	1.20	17.19	17.19	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	17.19	7.65	HGL Too High!
P10	MH3	MH4	1.20	17.15	17.15	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	17.19	7.28	HGL Too High!
P13	MH4	MH5	1.20	16.99	16.99	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	17.15	7.09	HGL Too High!
P15	MH5	MH41	1.60	16.84	16.84	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	16.99	7.40	HGL Too High!
P9	DI3	MH3	1.00	17.19	17.19	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.19	6.62	HGL Too High!
P8	DI17	MH3	1.00	17.19	17.19	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.19	6.96	HGL Too High!
P12	DI4	MH4	1.00	17.15	17.15	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	17.17	6.48	HGL Too High!
P11	DI18	MH4	1.00	17.15	17.15	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.17	6.56	HGL Too High!
P14	DI5	MH5	1.00	16.99	16.99	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.00	6.61	HGL Too High!
P18	DI6	MH6	1.00	17.01	17.01	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	17.04	7.13	HGL Too High!
P16	MH6	MH5	1.20	16.99	16.99	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	17.01	7.55	HGL Too High!
P17	DI49	MH6	1.00	17.01	17.01	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.02	7.08	HGL Too High!
P32	DI23	MH12	1.00	17.08	17.08	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	17.10	7.11	HGL Too High!
P31	DI9	MH12	1.00	17.08	17.08	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.09	7.13	HGL Too High!
P30	MH12	MH11	1.60	17.05	17.05	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	17.08	7.48	HGL Too High!
P27	MH11	MH10	1.60	16.92	16.92	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	17.05	7.21	HGL Too High!
P25	MH10	MH9	1.60	16.87	16.87	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	16.92	7.54	HGL Too High!
P22	MH9	MH8	1.60	16.77	16.77	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	16.87	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	16.77	16.77	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	16.82	7.34	HGL Too High!
P28	DI22	MH11	1.00	17.05	17.05	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	17.07	6.74	HGL Too High!
P29	DI8	MH11	1.00	17.05	17.05	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.06	6.92	HGL Too High!
P26	DI21	MH10	1.00	16.92	16.92	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.92	7.23	HGL Too High!
P23	DI20	MH9	1.00	16.87	16.87	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	16.88	7.38	HGL Too High!
P24	DI7	MH9	1.00	16.87	16.87	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.87	7.48	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: ___ of ___
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	Market Street (to Central Green Outfall)	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvatu (O, deg)	Curved align; add Hc = (H_c, ft)	Contraction Loss (H_o, ft)	Q V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P4	DI19	MH1	1.00	18.49	18.49	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.49	7.41	
P5	MH1	MH2	1.20	18.49	18.49	18	0.5	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	18.49	7.93	HGL Too High!
P7	MH2	MH3	1.20	18.49	18.49	18	0.5	0.3	1	73.8	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	18.49	7.65	HGL Too High!
P10	MH3	MH4	1.20	18.45	18.45	18	2.4	1.4	8	53.7	0.0004	0.02	0	0.00	0.01	0.1	1.0	0.8	0.9	0.0	87	0.01	0.02	1.0	0.5	0.01	0.03	18.49	7.28	HGL Too High!
P13	MH4	MH5	1.20	18.29	18.29	18	5.5	3.1	84	59.3	0.0023	0.14	0	0.00	0.04	3.3	1.6	1.3	1.4	0.0	8	0.00	0.05	1.0	0.5	0.03	0.16	18.45	7.09	HGL Too High!
P15	MH5	MH41	1.60	18.14	18.14	24	8.6	2.7	90	50	0.0012	0.06	0	0.00	0.03	17.1	1.3	2.6	3.1	0.1	84	0.10	0.18	1.0	0.5	0.09	0.15	18.29	7.40	HGL Too High!
P9	DI3	MH3	1.00	18.49	18.49	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.49	6.62	HGL Too High!
P8	DI17	MH3	1.00	18.49	18.49	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.49	6.96	HGL Too High!
P12	DI4	MH4	1.00	18.45	18.45	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	18.47	6.48	HGL Too High!
P11	DI18	MH4	1.00	18.45	18.45	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.47	6.56	HGL Too High!
P14	DI5	MH5	1.00	18.29	18.29	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.30	6.61	HGL Too High!
P18	DI6	MH6	1.00	18.31	18.31	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	18.34	7.13	HGL Too High!
P16	MH6	MH5	1.20	18.29	18.29	18	2.1	1.2	86	40	0.0004	0.01	0	0.00	0.01	2.3	0.2	0.0	1.4	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	18.31	7.55	HGL Too High!
P17	DI49	MH6	1.00	18.31	18.31	15	0.5	0.4	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.32	7.08	HGL Too High!
P32	DI23	MH12	1.00	18.38	18.38	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	18.40	7.11	HGL Too High!
P31	DI9	MH12	1.00	18.38	18.38	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.39	7.13	HGL Too High!
P30	MH12	MH11	1.60	18.35	18.35	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	18.38	7.48	HGL Too High!
P27	MH11	MH10	1.60	18.22	18.22	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	18.35	7.21	HGL Too High!
P25	MH10	MH9	1.60	18.17	18.17	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	18.22	7.54	HGL Too High!
P22	MH9	MH8	1.60	18.07	18.07	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	18.17	7.85	HGL Too High!
P-80	DI-80	MH-08	1.00	18.07	18.07	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	18.12	7.34	HGL Too High!
P28	DI22	MH11	1.00	18.35	18.35	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	18.37	6.74	HGL Too High!
P29	DI8	MH11	1.00	18.35	18.35	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.36	6.92	HGL Too High!
P26	DI21	MH10	1.00	18.22	18.22	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.22	7.23	HGL Too High!
P23	DI20	MH9	1.00	18.17	18.17	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	18.18	7.38	HGL Too High!
P24	DI7	MH9	1.00	18.17	18.17	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.17	7.48	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 1	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-158	DI-158	DI-154	3887	225	4112	0.09	0.91	0.09	0.09	6.0	0.00	4.01	**0.34**	15	100	0.012	0.000024	0.0053	4.2	**5.1**	2.0	0.82	6.82	**4.36**	3.83	Q ok
P-154	DI-154	MH-155	3023	31	3054	0.07	0.94	0.07	0.15	6.0	6.82	3.88	**0.59**	15	24	0.012	0.000071	0.0042	3.7	**4.5**	2.6	0.16	6.97	**3.73**	3.63	Q ok
P-155	MH-155	DI-156	1	0	1	0.00	0.95	0.00	0.69	6.0	6.97	3.84	**2.64**	18	51	0.012	0.000539	0.0039	4.0	**7.1**	3.6	0.23	7.21	3.53	3.33	Q ok
P-156	DI-156	DI-152	2725	0	2725	0.06	0.95	0.06	0.75	6.0	7.21	3.81	**2.85**	18	33	0.012	0.000626	0.0039	4.0	**7.1**	3.7	0.15	7.36	3.23	3.10	Q ok
P-152	DI-152	MH-140	3517	0	3517	0.08	0.95	0.08	2.41	6.0	7.36	3.78	**9.09**	**30**	97	0.012	0.000419	0.0040	5.7	**28.2**	4.9	0.33	7.69	3.00	2.61	Q ok
P-140	MH-140	DI-141	1	0	1	0.00	0.95	0.00	3.65	6.0	7.69	3.73	**13.61**	36	97	0.012	0.000355	0.0040	6.5	**45.8**	5.5	0.29	7.98	2.51	2.12	Q ok
P-141	DI-141	DI-142	3263	65	3328	0.08	0.93	0.07	3.72	6.0	7.98	3.68	**13.69**	36	96	0.012	0.000359	0.0040	6.4	**45.5**	5.5	0.29	8.27	2.02	1.64	Q ok
P-142	DI-142	DI-143	3699	195	3894	0.09	0.91	0.08	3.80	6.0	8.27	3.63	**13.79**	36	68	0.012	0.000364	0.0040	6.4	**45.5**	5.5	0.21	8.48	1.54	1.27	Q ok
P-143	DI-143	MH-170	5428	266	5694	0.13	0.91	0.12	4.71	6.0	8.48	3.59	**16.93**	36	115	0.012	0.000549	0.0040	6.5	**45.7**	5.8	0.33	8.81	1.17	0.71	Q ok
P-170	MH-170	MH-171	1	0	1	0.00	0.95	0.00	8.26	6.0	8.81	3.54	**29.27**	48	55	0.012	0.000354	0.0040	7.8	**98.4**	6.7	0.14	8.95	0.61	0.39	Q ok
P-171	MH-171	MH-172	1	0	1	0.00	0.95	0.00	8.44	6.0	8.95	3.52	**29.74**	48	50	0.012	0.000365	0.0040	7.8	**98.4**	6.7	0.13	9.07	0.29	0.09	Q ok
P-172	MH-172	MH-173	1	0	1	0.00	0.95	0.00	9.41	6.0	9.07	3.49	**32.85**	48	44	0.012	0.000446	0.0041	7.9	**99.5**	7.1	0.10	9.18	-0.01	-0.19	Q ok
P-173	MH-173	OUTFALL	1	0	1	0.00	0.95	0.00	9.98	6.0	9.18	3.47	**34.69**	**48**	64	0.012	0.000497	0.0041	7.9	**99.2**	7.1	0.15	9.33	-0.29	**-0.55**	Q ok
P-174	DI-174	MH-171	3578	530	4108	0.09	0.85	0.08	0.08	6.0	0.00	4.01	**0.32**	18	33	0.012	0.000008	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-175	DI-175	MH-171	4118	530	4648	0.11	0.86	0.09	0.09	6.0	0.00	4.01	**0.37**	18	33	0.012	0.000011	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-176	B4 North	MH-172	22780	0	22780	0.52	0.95	0.50	0.50	6.0	0.00	4.01	**1.99**	18	55	0.012	0.000307	0.0049	4.5	**8.0**	3.7	0.25	6.25	1.26	0.99	Q ok
P-177	B2 South	MH-172	21809	0	21809	0.50	0.95	0.48	0.48	6.0	0.00	4.01	**1.91**	18	55	0.012	0.000281	0.0049	4.5	**8.0**	3.7	0.25	6.25	1.26	0.99	Q ok
P-178	TD-03	DI-179	8687	0	8687	0.20	0.95	0.19	0.19	6.0	0.00	4.01	**0.76**	8	56	0.011	0.002833	0.0509	9.2	**3.2**	7.6	0.12	6.12	8.55	5.70	Q ok
P-179	DI-179	MH-173	6306	3055	9361	0.21	0.70	0.15	0.34	6.0	6.12	4.00	**1.36**	15	30	0.012	0.000376	0.0500	12.8	**15.6**	7.7	0.07	6.19	3.21	1.71	Q ok
P-180	TD-02	DI-181	4084	0	4084	0.09	0.95	0.09	0.09	6.0	0.00	4.01	**0.36**	8	45	0.011	0.000626	0.0500	9.1	**3.2**	5.5	0.14	6.14	8.50	6.25	Q ok
P-181	DI-181	MH-173	6222	2906	9128	0.21	0.70	0.15	0.24	6.0	6.14	4.00	**0.95**	15	30	0.012	0.000183	0.0500	12.8	**15.6**	6.2	0.08	6.22	3.21	1.71	Q ok
P-115	B5 West	MH-116	33468	0	33468	0.77	0.95	0.73	0.73	6.0	0.00	4.01	**2.93**	18	17	0.012	0.000662	0.0047	4.4	**7.8**	4.1	0.07	6.07	3.84	3.76	Q ok
P-116	MH-116	DI-117	1	0	1	0.00	0.95	0.00	0.73	6.0	6.07	4.00	**2.92**	18	60	0.012	0.000657	0.0050	4.6	**8.0**	4.1	0.24	6.31	3.66	3.36	Q ok
P-117	DI-117	DI-118	2919	167	3086	0.07	0.91	0.06	0.79	6.0	6.31	3.96	**3.15**	18	71	0.012	0.000765	0.0051	4.6	**8.1**	4.2	0.28	6.59	3.26	2.90	Q ok
P-118	DI-118	DI-113	2866	196	3062	0.07	0.90	0.06	0.86	6.0	6.59	3.91	**3.35**	18	27	0.012	0.000869	0.0048	4.5	**7.9**	4.1	0.11	6.70	2.80	2.67	Q ok
P-113	DI-113	DI-114	2882	195	3077	0.07	0.90	0.06	1.48	6.0	6.70	3.89	**5.77**	18	41	0.012	0.002568	0.0200	9.1	**16.1**	8.2	0.08	6.79	2.57	1.75	Q ok
P-114	DI-114	MH-170	1592	20	1612	0.04	0.94	0.03	1.52	6.0	6.79	3.88	**5.88**	18	47	0.012	0.002667	0.0200	9.1	**16.1**	8.2	0.10	6.88	1.65	0.71	Q ok
P-110	B4 South	MH-111	22751	0	22751	0.52	0.95	0.50	0.50	6.0	0.00	4.01	**1.99**	18	17	0.012	0.000306	0.0053	4.7	**8.3**	3.8	0.07	6.07	3.61	3.52	Q ok
P-111	MH-111	DI-112	1	0	1	0.00	0.95	0.00	0.50	6.0	6.07	4.00	**1.98**	18	60	0.012	0.000303	0.0050	4.6	**8.0**	3.7	0.27	6.34	3.42	3.12	Q ok
P-112	DI-112	DI-113	2877	164	3041	0.07	0.91	0.06	0.56	6.0	6.34	3.96	**2.22**	18	71	0.012	0.000380	0.0049	4.5	**8.0**	3.8	0.31	6.65	3.02	2.67	Q ok
P-120	DI-120	DI-121	2879	334	3213	0.07	0.87	0.06	0.06	6.0	0.00	4.01	**0.26**	15	22	0.012	0.000014	0.0032	3.2	**3.9**	1.6	0.23	6.23	**3.96**	3.89	Q ok
P-121	DI-121	DI-122	5403	1316	6719	0.15	0.80	0.12	0.19	6.0	6.23	3.98	**0.75**	15	84	0.012	0.000114	0.0031	3.2	**3.9**	2.4	0.59	6.82	3.79	3.53	Q ok
P-122	DI-122	MH-123	4404	1304	5708	0.13	0.77	0.10	0.29	6.0	6.82	3.88	**1.12**	15	56	0.012	0.000256	0.0030	3.1	**3.9**	2.7	0.35	7.17	3.43	3.26	Q ok
P-123	MH-123	DI-124	1	0	1	0.00	0.95	0.00	1.01	6.0	7.17	3.81	**3.87**	**24**	36	0.012	0.000249	0.0036	4.7	**14.7**	3.8	0.16	7.33	3.16	3.03	Q ok
P-124	DI-124	MH-135	3437	323	3760	0.09	0.88	0.08	1.13	6.0	7.33	3.79	**4.27**	**24**	31	0.012	0.000304	0.0048	5.4	**17.0**	4.4	0.12	7.44	2.93	2.78	Q ok
P-125	DI-125	DI-124	1587	15	1602	0.04	0.94	0.03	0.03	6.0	0.00	4.01	**0.14**	15	45	0.012	0.000004	0.0040	3.6	**4.4**	1.8	0.42	6.42	3.21	3.03	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 1	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-126	B5 North	MH-123	33276	0	33276	0.76	0.95	0.73	0.73	6.0	0.00	4.01	**2.91**	18	17	0.012	0.000655	0.0053	4.7	**8.3**	4.2	0.07	6.07	3.36	3.27	Q ok
P-130	DI-130	DI-131	2606	339	2945	0.07	0.86	0.06	0.06	6.0	0.00	4.01	**0.23**	15	22	0.012	0.000011	0.0032	3.2	**3.9**	1.6	0.23	6.23	**3.96**	3.89	Q ok
P-131	DI-131	DI-132	5203	1533	6736	0.15	0.77	0.12	0.18	6.0	6.23	3.98	**0.71**	15	83	0.012	0.000102	0.0030	3.1	**3.8**	2.3	0.59	6.82	3.79	3.54	Q ok
P-132	DI-132	MH-133	4517	1246	5763	0.13	0.78	0.10	0.28	6.0	6.82	3.88	**1.09**	15	56	0.012	0.000244	0.0030	3.1	**3.9**	2.7	0.35	7.17	3.44	3.27	Q ok
P-133	MH-133	DI-134	1	0	1	0.00	0.95	0.00	0.82	6.0	7.17	3.81	**3.12**	24	36	0.012	0.000162	0.0031	4.3	**13.5**	3.5	0.17	7.34	3.17	3.06	Q ok
P-134	DI-134	MH-135	4193	284	4477	0.10	0.90	0.09	0.91	6.0	7.34	3.79	**3.45**	**24**	31	0.012	0.000198	0.0035	4.6	**14.6**	3.8	0.14	7.48	2.96	2.85	Q ok
P-135	MH-135	MH-170	1	0	1	0.00	0.95	0.00	2.04	6.0	7.48	3.76	**7.65**	**30**	94	0.012	0.000297	0.0039	5.7	**27.9**	4.7	0.34	7.81	2.67	2.30	Q ok
P-136	B3 South	MH-133	24569	0	24569	0.56	0.95	0.54	0.54	6.0	0.00	4.01	**2.15**	18	17	0.012	0.000357	0.0047	4.4	**7.8**	3.8	0.08	6.08	3.36	3.28	Q ok
P-144	DI-144	MH-145	2618	65	2683	0.06	0.93	0.06	0.06	6.0	0.00	4.01	**0.23**	15	55	0.012	0.000011	0.0051	4.1	**5.0**	2.0	0.46	6.46	3.79	3.51	Q ok
P-145	MH-145	DI-146	1	0	1	0.00	0.95	0.00	0.59	6.0	6.46	3.93	**2.33**	18	39	0.012	0.000419	0.0049	4.5	**7.9**	3.8	0.17	6.63	3.41	3.22	Q ok
P-146	DI-146	DI-147	3675	195	3870	0.09	0.91	0.08	0.67	6.0	6.63	3.91	**2.64**	18	68	0.012	0.000537	0.0050	4.6	**8.0**	4.1	0.28	6.91	3.12	2.78	Q ok
P-147	DI-147	DI-143	5191	266	5457	0.13	0.91	0.11	0.79	6.0	6.91	3.86	**3.04**	18	25	0.012	0.000716	0.0052	4.6	**8.2**	4.2	0.10	7.01	2.68	2.55	Q ok
P-148	B3 West	MH-145	24569	0	24569	0.56	0.95	0.54	0.54	6.0	0.00	4.01	**2.15**	18	17	0.012	0.000357	0.0053	4.7	**8.3**	3.8	0.07	6.07	3.60	3.51	Q ok
P-167	DI-167	DI-159	3909	227	4136	0.09	0.91	0.09	0.09	6.0	6.00	4.01	**0.35**	15	18	0.012	0.000024	0.0033	3.3	**4.0**	2.0	0.15	6.15	4.29	4.23	Q ok
P-159	DI-159	DI-150	3909	227	4136	0.09	0.91	0.09	0.17	6.0	6.15	3.98	**0.69**	15	100	0.012	0.000096	0.0053	4.2	**5.1**	2.9	0.57	6.73	4.13	3.60	Q ok
P-150	DI-150	MH-151	3037	0	3037	0.07	0.95	0.07	0.24	6.0	0.00	4.01	**0.96**	15	24	0.012	0.000187	0.0042	3.7	**4.5**	2.8	0.14	6.14	3.50	3.40	Q ok
P-151	MH-151	DI-152	1	0	1	0.00	0.95	0.00	1.58	6.0	6.14	4.00	**6.33**	24	51	0.012	0.000666	0.0039	4.9	**15.3**	4.5	0.19	6.33	3.30	3.10	Q ok
P-153	B1	MH-151	61668	0	61668	1.42	0.95	1.34	1.34	6.0	0.00	4.01	**5.40**	24	17	0.012	0.000485	0.0100	7.8	**24.5**	5.9	0.05	6.05	3.57	3.40	Q ok
P-157	B3 North	MH-155	24569	0	24569	0.56	0.95	0.54	0.54	6.0	0.00	4.01	**2.15**	18	18	0.012	0.000357	0.0050	4.6	**8.0**	3.7	0.08	6.08	3.72	3.63	Q ok
P-166	B2 North	MH-163	21657	0	21657	0.50	0.95	0.47	0.47	6.0	0.00	4.01	**1.89**	18	50	0.012	0.000277	0.0050	4.6	**8.0**	3.7	0.22	6.22	3.62	3.37	Q ok
P-163	MH-163	MH-140	1	0	1	0.00	0.95	0.00	1.24	6.0	6.22	3.98	**4.95**	18	44	0.012	0.001892	0.0150	7.9	**13.9**	7.1	0.10	6.33	3.27	2.61	Q ok

KEY	
	Upsized from Semi-Final Design to have capacity for 50-yr design storm
	Optional Upsize-50-yr design storm results in >85% Full
	No Change from Semi-Final Design

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	4.81	4.83	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	4.84	7.70	HGL ok
P-154	DI-154	MH-155	1.00	4.81	4.81	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.81	9.06	HGL ok
P-155	MH-155	DI-156	1.20	4.77	4.77	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	*0.5*	0.02	0.05	4.81	10.06	HGL ok
P-156	DI-156	DI-152	1.20	4.70	4.70	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	4.77	11.07	HGL ok
P-152	DI-152	MH-140	2.00	4.59	4.61	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	4.70	11.07	HGL ok
P-140	MH-140	DI-141	2.40	4.11	4.52	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	*0.5*	0.04	0.07	4.59	12.04	HGL ok
P-141	DI-141	DI-142	2.40	3.82	4.04	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	4.11	11.02	HGL ok
P-142	DI-142	DI-143	2.40	3.76	3.76	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	3.82	10.52	HGL ok
P-143	DI-143	MH-170	2.40	3.67	3.67	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	*0.5*	0.03	0.09	3.76	10.28	HGL ok
P-170	MH-170	MH-171	3.20	3.36	3.59	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	*0.5*	0.06	0.08	3.67	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.32	3.32	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.05	3.36	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.27	3.27	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	*0.5*	0.03	0.05	3.32	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.20**	**3.20**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	***0.5***	**0.03**	**0.07**	**3.27**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	3.36	3.36	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.36	10.61	HGL ok
P-175	DI-175	MH-171	1.20	3.36	3.36	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.36	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.32	3.32	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	3.34	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.32	3.32	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	3.33	10.00	HGL ok
P-178	TD-03	DI-179	0.53	3.37	6.23	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	6.41	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.27	3.27	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	*1.3*	1.0	0.09	0.10	3.37	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.29	6.78	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	6.82	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.27	3.27	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	*1.3*	1.0	0.02	0.03	3.29	9.25	HGL ok
P-115	B5 West	MH-116	1.20	4.63	4.96	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	4.98	10.00	HGL ok
P-116	MH-116	DI-117	1.20	4.32	4.56	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	*0.5*	0.03	0.07	4.63	11.99	HGL ok
P-117	DI-117	DI-118	1.20	4.23	4.23	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	4.32	11.71	HGL ok
P-118	DI-118	DI-113	1.20	4.14	4.14	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	4.23	11.30	HGL ok
P-113	DI-113	DI-114	1.20	3.94	3.94	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	4.14	11.30	HGL ok
P-114	DI-114	MH-170	1.20	3.67	3.67	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	3.94	10.75	HGL ok
P-110	B4 South	MH-111	1.20	4.35	4.72	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.01	4.73	10.00	HGL ok
P-111	MH-111	DI-112	1.20	4.19	4.32	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	*0.5*	0.01	0.03	4.35	11.99	HGL ok
P-112	DI-112	DI-113	1.20	4.14	4.14	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	*1.3*	1.0	0.02	0.05	4.19	11.71	HGL ok
P-120	DI-120	DI-121	1.00	4.70	4.89	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-121	DI-121	DI-122	1.00	4.69	4.69	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.01	4.70	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.66	4.66	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.02	4.69	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.42	4.63	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	*0.5*	0.02	0.03	4.66	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.35	4.38	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	4.42	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.42	4.42	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.42	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.66	4.66	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	4.68	10.00	HGL ok
P-130	DI-130	DI-131	1.00	4.71	4.89	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.70	4.70	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	4.71	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.68	4.68	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.02	4.70	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.48	4.66	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	*0.5*	0.01	0.02	4.68	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.35	4.45	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	4.48	9.44	HGL ok
P-135	MH-135	MH-170	2.00	3.67	4.30	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	*0.5*	0.02	0.05	4.35	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.68	4.68	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	4.69	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	4.45	4.51	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.51	11.02	HGL ok
P-145	MH-145	DI-146	1.20	4.04	4.42	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	4.45	10.87	HGL ok
P-146	DI-146	DI-147	1.20	3.84	3.98	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	4.04	10.52	HGL ok
P-147	DI-147	DI-143	1.20	3.76	3.76	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	3.84	10.28	HGL ok
P-148	B3 West	MH-145	1.20	4.45	4.71	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.72	10.00	HGL ok
P-167	DI-167	DI-159	1.00	4.83	5.23	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.23	7.48	HGL ok
P-159	DI-159	DI-150	1.00	4.77	4.77	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	4.83	7.70	HGL ok
P-150	DI-150	MH-151	1.00	4.77	4.77	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	4.77	9.06	HGL ok
P-151	MH-151	DI-152	1.60	4.70	4.70	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	4.77	10.06	HGL ok
P-153	B1	MH-151	1.60	4.77	5.00	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	5.01	10.00	HGL ok
P-157	B3 North	MH-155	1.20	4.81	4.83	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.84	10.00	HGL ok
P-166	B2 North	MH-163	1.20	4.71	4.71	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	4.72	10.00	HGL ok
P-163	MH-163	MH-140	1.20	4.59	4.59	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	4.71	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 1 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D — 0.8D (ft)	Tailwater, link to Inlet WSE of downstream pipe — TW (ft)	Outlet W. S. Elevation — HGL Dn (ft)	Outflow Pipe Diameter — D_o (in)	Outflow Pipe Design Flow — Q_o (cfs)	Pressure-flow Vel., $V_o=Q_o/A$ — V_o (fps)	Skew angle vs. — Δ_o (deg)	Outflow Pipe Length — L (ft)	Friction Slope — S_{fo} (ft/ft)	Friction Loss — H_f (ft)	Angle of Curvat — O (deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ — H_c (ft)	Contraction Loss — H_o (ft)	Q*V for determining controlling inflow pipe — Q1V1 (ft^4/s^2)	Q*V for determining controlling inflow pipe — Q2V2 (ft^4/s^2)	Q*V for determining controlling inflow pipe — Q3V3 (ft^4/s^2)	Controlling Inflow Velocity — Vi	Expansion Loss — Hi (ft)	Controlling In-flow skew — Δ_i (deg)	Bend Loss — H_Δ (ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ — H_t (cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss — $H_{t\ adj}$ (ft)	Tot. H Loss, $H = H_f + H_{t\ adj}$ — H (ft)	Inlet W. S. Elevation — HGL Up (ft)	Top of Grate — T/G (ft)	HGL Check
P-158	DI-158	DI-154	1.00	4.81	4.83	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	4.84	7.70	HGL ok
P-154	DI-154	MH-155	1.00	4.81	4.81	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.81	9.06	HGL ok
P-155	MH-155	DI-156	1.20	4.77	4.77	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	0.5	0.02	0.05	4.81	10.06	HGL ok
P-156	DI-156	DI-152	1.20	4.70	4.70	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	4.77	11.07	HGL ok
P-152	DI-152	MH-140	2.00	4.59	4.61	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	4.70	11.07	HGL ok
P-140	MH-140	DI-141	2.40	4.11	4.52	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	0.5	0.04	0.07	4.59	12.04	HGL ok
P-141	DI-141	DI-142	2.40	3.82	4.04	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	4.11	11.02	HGL ok
P-142	DI-142	DI-143	2.40	3.76	3.76	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	3.82	10.52	HGL ok
P-143	DI-143	MH-170	2.40	3.67	3.67	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	0.5	0.03	0.09	3.76	10.28	HGL ok
P-170	MH-170	MH-171	3.20	3.56	3.59	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	0.5	0.06	0.08	3.67	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.52	3.52	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	3.56	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.47	3.47	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	0.5	0.03	0.05	3.52	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.40**	**3.40**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	**0.5**	**0.03**	**0.07**	**3.47**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	3.56	3.56	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.56	10.61	HGL ok
P-175	DI-175	MH-171	1.20	3.56	3.56	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.56	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.52	3.52	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	3.54	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.52	3.52	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	3.53	10.00	HGL ok
P-178	TD-03	DI-179	0.53	3.57	6.23	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	6.41	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.47	3.47	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	1.3	1.0	0.09	0.10	3.57	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.49	6.78	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	6.82	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.47	3.47	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	1.3	1.0	0.02	0.03	3.49	9.25	HGL ok
P-115	B5 West	MH-116	1.20	4.63	4.96	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	4.98	10.00	HGL ok
P-116	MH-116	DI-117	1.20	4.32	4.56	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	0.5	0.03	0.07	4.63	11.99	HGL ok
P-117	DI-117	DI-118	1.20	4.23	4.23	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	4.32	11.71	HGL ok
P-118	DI-118	DI-113	1.20	4.14	4.14	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	4.23	11.30	HGL ok
P-113	DI-113	DI-114	1.20	3.94	3.94	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	4.14	11.30	HGL ok
P-114	DI-114	MH-170	1.20	3.67	3.67	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	3.94	10.75	HGL ok
P-110	B4 South	MH-111	1.20	4.35	4.72	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	4.73	10.00	HGL ok
P-111	MH-111	DI-112	1.20	4.19	4.32	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	0.5	0.01	0.03	4.35	11.99	HGL ok
P-112	DI-112	DI-113	1.20	4.14	4.14	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	1.3	1.0	0.02	0.05	4.19	11.71	HGL ok
P-120	DI-120	DI-121	1.00	4.70	4.89	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-121	DI-121	DI-122	1.00	4.69	4.69	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.01	4.70	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.66	4.66	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	1.3	1.0	0.01	0.02	4.69	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.42	4.63	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	0.5	0.02	0.03	4.66	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.35	4.38	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	4.42	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.42	4.42	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.42	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.66	4.66	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	4.68	10.00	HGL ok
P-130	DI-130	DI-131	1.00	4.71	4.89	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.70	4.70	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	4.71	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.68	4.68	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	1.3	1.0	0.01	0.02	4.70	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.48	4.66	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	0.5	0.01	0.02	4.68	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.35	4.45	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	4.48	9.44	HGL ok
P-135	MH-135	MH-170	2.00	3.67	4.30	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	0.5	0.02	0.05	4.35	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.68	4.68	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.69	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	4.45	4.51	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.51	11.02	HGL ok
P-145	MH-145	DI-146	1.20	4.04	4.42	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	4.45	10.87	HGL ok
P-146	DI-146	DI-147	1.20	3.84	3.98	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	4.04	10.52	HGL ok
P-147	DI-147	DI-143	1.20	3.76	3.76	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	3.84	10.28	HGL ok
P-148	B3 West	MH-145	1.20	4.45	4.71	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.72	10.00	HGL ok
P-167	DI-167	DI-159	1.00	4.83	5.23	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.23	7.48	HGL ok
P-159	DI-159	DI-150	1.00	4.77	4.77	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	4.83	7.70	HGL ok
P-150	DI-150	MH-151	1.00	4.77	4.77	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	4.77	9.06	HGL ok
P-151	MH-151	DI-152	1.60	4.70	4.70	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	4.77	10.06	HGL ok
P-153	B1	MH-151	1.60	4.77	5.00	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	5.01	10.00	HGL ok
P-157	B3 North	MH-155	1.20	4.81	4.83	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.84	10.00	HGL ok
P-166	B2 North	MH-163	1.20	4.71	4.71	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	4.72	10.00	HGL ok
P-163	MH-163	MH-140	1.20	4.59	4.59	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	4.71	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\ adj}$ ft	Tot. H Loss, $H=H_f+H_{t\ adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	7.64	7.64	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.66	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	7.64	7.64	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.64	9.06	HGL ok
P-155	MH-155	DI-156	1.20	7.59	7.59	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	0.5	0.02	0.05	7.64	10.06	HGL ok
P-156	DI-156	DI-152	1.20	7.52	7.52	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	7.59	11.07	HGL ok
P-152	DI-152	MH-140	2.00	7.44	7.44	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	7.52	11.07	HGL ok
P-140	MH-140	DI-141	2.40	7.37	7.37	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	0.5	0.04	0.07	7.44	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.29	7.29	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	7.37	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.23	7.23	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	7.29	10.52	HGL ok
P-143	DI-143	MH-170	2.40	7.14	7.14	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	0.5	0.03	0.09	7.23	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.06	7.06	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	0.5	0.06	0.08	7.14	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.02	7.02	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	7.06	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.97	6.97	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	0.5	0.03	0.05	7.02	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	**0.5**	**0.03**	**0.07**	**6.97**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.06	7.06	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.06	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.06	7.06	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.06	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.02	7.02	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	7.04	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.02	7.02	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	7.03	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.07	7.07	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	7.25	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.97	6.97	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	1.3	1.0	0.09	0.10	7.07	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.99	6.99	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	7.03	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.97	6.97	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	1.3	1.0	0.02	0.03	6.99	9.25	HGL ok
P-115	B5 West	MH-116	1.20	7.86	7.86	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	7.88	10.00	HGL ok
P-116	MH-116	DI-117	1.20	7.79	7.79	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	0.5	0.03	0.07	7.86	11.99	HGL ok
P-117	DI-117	DI-118	1.20	7.71	7.71	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	7.79	11.71	HGL ok
P-118	DI-118	DI-113	1.20	7.62	7.62	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	7.71	11.30	HGL ok
P-113	DI-113	DI-114	1.20	7.42	7.42	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	7.62	11.30	HGL ok
P-114	DI-114	MH-170	1.20	7.14	7.14	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	7.42	10.75	HGL ok
P-110	B4 South	MH-111	1.20	7.69	7.69	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	7.70	10.00	HGL ok
P-111	MH-111	DI-112	1.20	7.66	7.66	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	0.5	0.01	0.03	7.69	11.99	HGL ok
P-112	DI-112	DI-113	1.20	7.62	7.62	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	1.3	1.0	0.02	0.05	7.66	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.30	7.30	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.30	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.28	7.28	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.01	7.30	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.26	7.26	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	1.3	1.0	0.01	0.02	7.28	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.23	7.23	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	0.5	0.02	0.03	7.26	8.91	HGL ok
P-124	DI-124	MH-135	1.60	7.19	7.19	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	7.23	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.23	7.23	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.23	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.26	7.26	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	7.28	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.27	7.27	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.27	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.25	7.25	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	7.27	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.23	7.23	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	1.3	1.0	0.01	0.02	7.25	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.21	7.21	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	0.5	0.01	0.02	7.23	8.91	HGL ok
P-134	DI-134	MH-135	1.60	7.19	7.19	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	7.21	9.44	HGL ok
P-135	MH-135	MH-170	2.00	7.14	7.14	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	0.5	0.02	0.05	7.19	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.23	7.23	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.24	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	7.41	7.41	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.41	11.02	HGL ok
P-145	MH-145	DI-146	1.20	7.38	7.38	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	7.41	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.31	7.31	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	7.38	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.23	7.23	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	7.31	10.28	HGL ok
P-148	B3 West	MH-145	1.20	7.41	7.41	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.42	10.00	HGL ok
P-167	DI-167	DI-159	1.00	7.66	7.66	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.66	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	7.60	7.60	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	7.66	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	7.59	7.59	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.60	9.06	HGL ok
P-151	MH-151	DI-152	1.60	7.52	7.52	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	7.59	10.06	HGL ok
P-153	B1	MH-151	1.60	7.59	7.59	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	7.60	10.00	HGL ok
P-157	B3 North	MH-155	1.20	7.64	7.64	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.65	10.00	HGL ok
P-166	B2 North	MH-163	1.20	7.55	7.55	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	7.57	10.00	HGL ok
P-163	MH-163	MH-140	1.20	7.44	7.44	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	7.55	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	8.14	8.14	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.16	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	8.14	8.14	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.14	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	8.09	8.09	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	0.5	0.02	0.05	8.14	10.06	HGL ok
P-156	DI-156	DI-152	1.20	8.02	8.02	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	8.09	11.07	HGL ok
P-152	DI-152	MH-140	2.00	7.94	7.94	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	8.02	11.07	HGL ok
P-140	MH-140	DI-141	2.40	7.87	7.87	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	0.5	0.04	0.07	7.94	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.79	7.79	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	7.87	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.73	7.73	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	7.79	10.52	HGL ok
P-143	DI-143	MH-170	2.40	7.64	7.64	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	0.5	0.03	0.09	7.73	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.56	7.56	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	0.5	0.06	0.08	7.64	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.52	7.52	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	7.56	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.47	7.47	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	0.5	0.03	0.05	7.52	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	**0.5**	**0.03**	**0.07**	**7.47**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.56	7.56	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.56	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.56	7.56	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.56	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.52	7.52	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	7.54	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.52	7.52	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	7.53	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.57	7.57	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	7.75	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.47	7.47	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	1.3	1.0	0.09	0.10	7.57	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.49	7.49	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	7.53	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.47	7.47	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	1.3	1.0	0.02	0.03	7.49	9.25	HGL ok
P-115	B5 West	MH-116	1.20	8.36	8.36	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	8.38	10.00	HGL ok
P-116	MH-116	DI-117	1.20	8.29	8.29	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	0.5	0.03	0.07	8.36	11.99	HGL ok
P-117	DI-117	DI-118	1.20	8.21	8.21	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	8.29	11.71	HGL ok
P-118	DI-118	DI-113	1.20	8.12	8.12	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	8.21	11.30	HGL ok
P-113	DI-113	DI-114	1.20	7.92	7.92	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	8.12	11.30	HGL ok
P-114	DI-114	MH-170	1.20	7.64	7.64	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	7.92	10.75	HGL ok
P-110	B4 South	MH-111	1.20	8.19	8.19	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	8.20	10.00	HGL ok
P-111	MH-111	DI-112	1.20	8.16	8.16	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	0.5	0.01	0.03	8.19	11.99	HGL ok
P-112	DI-112	DI-113	1.20	8.12	8.12	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	1.3	1.0	0.02	0.05	8.16	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.80	7.80	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.80	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.78	7.78	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.01	7.80	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.76	7.76	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	1.3	1.0	0.01	0.02	7.78	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.73	7.73	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	0.5	0.02	0.03	7.76	8.91	HGL ok
P-124	DI-124	MH-135	1.60	7.69	7.69	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	7.73	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.73	7.73	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.73	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.76	7.76	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	7.78	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.77	7.77	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.77	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.75	7.75	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	7.77	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.73	7.73	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	1.3	1.0	0.01	0.02	7.75	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.71	7.71	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	0.5	0.01	0.02	7.73	8.91	HGL ok
P-134	DI-134	MH-135	1.60	7.69	7.69	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	7.71	9.44	HGL ok
P-135	MH-135	MH-170	2.00	7.64	7.64	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	0.5	0.02	0.05	7.69	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.73	7.73	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.74	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	7.91	7.91	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.91	11.02	HGL ok
P-145	MH-145	DI-146	1.20	7.88	7.88	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	7.91	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.81	7.81	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	7.88	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.73	7.73	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	7.81	10.28	HGL ok
P-148	B3 West	MH-145	1.20	7.91	7.91	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.92	10.00	HGL ok
P-167	DI-167	DI-159	1.00	8.16	8.16	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.16	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	8.10	8.10	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	8.16	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	8.09	8.09	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.10	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.02	8.02	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	8.09	10.06	HGL ok
P-153	B1	MH-151	1.60	8.09	8.09	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	8.10	10.00	HGL ok
P-157	B3 North	MH-155	1.20	8.14	8.14	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.15	10.00	HGL ok
P-166	B2 North	MH-163	1.20	8.05	8.05	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	8.07	10.00	HGL ok
P-163	MH-163	MH-140	1.20	7.94	7.94	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	8.05	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 1 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	8.54	8.54	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.56	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	8.54	8.54	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.54	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	8.49	8.49	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	0.5	0.02	0.05	8.54	10.06	HGL ok
P-156	DI-156	DI-152	1.20	8.42	8.42	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	8.49	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.34	8.34	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	8.42	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.27	8.27	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	0.5	0.04	0.07	8.34	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.19	8.19	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	8.27	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.13	8.13	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	8.19	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.04	8.04	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	0.5	0.03	0.09	8.13	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.96	7.96	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	0.5	0.06	0.08	8.04	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.92	7.92	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	7.96	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.87	7.87	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	0.5	0.03	0.05	7.92	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	**0.5**	**0.03**	**0.07**	**7.87**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.96	7.96	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.96	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.96	7.96	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.96	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.92	7.92	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	7.94	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.92	7.92	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	7.93	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.97	7.97	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	8.15	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.87	7.87	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	1.3	1.0	0.09	0.10	7.97	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.89	7.89	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	7.93	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.87	7.87	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	1.3	1.0	0.02	0.03	7.89	9.25	HGL ok
P-115	B5 West	MH-116	1.20	8.76	8.76	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	8.78	10.00	HGL ok
P-116	MH-116	DI-117	1.20	8.69	8.69	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	0.5	0.03	0.07	8.76	11.99	HGL ok
P-117	DI-117	DI-118	1.20	8.61	8.61	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	8.69	11.71	HGL ok
P-118	DI-118	DI-113	1.20	8.52	8.52	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	8.61	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.32	8.32	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	8.52	11.30	HGL ok
P-114	DI-114	MH-170	1.20	8.04	8.04	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	8.32	10.75	HGL ok
P-110	B4 South	MH-111	1.20	8.59	8.59	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	8.60	10.00	HGL ok
P-111	MH-111	DI-112	1.20	8.56	8.56	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	0.5	0.01	0.03	8.59	11.99	HGL ok
P-112	DI-112	DI-113	1.20	8.52	8.52	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	1.3	1.0	0.02	0.05	8.56	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.20	8.20	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.20	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.18	8.18	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.01	8.20	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.16	8.16	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	1.3	1.0	0.01	0.02	8.18	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.13	8.13	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	0.5	0.02	0.03	8.16	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.09	8.09	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	8.13	9.44	HGL ok
P-125	DI-125	DI-124	1.00	8.13	8.13	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.13	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.16	8.16	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	8.18	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.17	8.17	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.17	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.15	8.15	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	8.17	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.13	8.13	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	1.3	1.0	0.01	0.02	8.15	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.11	8.11	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	0.5	0.01	0.02	8.13	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.09	8.09	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	8.11	9.44	HGL ok
P-135	MH-135	MH-170	2.00	8.04	8.04	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	0.5	0.02	0.05	8.09	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.13	8.13	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.14	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.31	8.31	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.31	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.28	8.28	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	8.31	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.21	8.21	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	8.28	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.13	8.13	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	8.21	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.31	8.31	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.32	10.00	HGL ok
P-167	DI-167	DI-159	1.00	8.56	8.56	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.56	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	8.50	8.50	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	8.56	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	8.49	8.49	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.50	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.42	8.42	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	8.49	10.06	HGL ok
P-153	B1	MH-151	1.60	8.49	8.49	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	8.50	10.00	HGL ok
P-157	B3 North	MH-155	1.20	8.54	8.54	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.55	10.00	HGL ok
P-166	B2 North	MH-163	1.20	8.45	8.45	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	8.47	10.00	HGL ok
P-163	MH-163	MH-140	1.20	8.34	8.34	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	8.45	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 1

Date: 2/23/23
Date: 3/23/23
-year (50-year for sumps)

Sheet No.: 3 of 5
Cm. No.: 20077

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle Δ_o	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	9.04	9.04	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.06	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.04	9.04	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.04	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	8.99	8.99	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	0.5	0.02	0.05	9.04	10.06	HGL ok
P-156	DI-156	DI-152	1.20	8.92	8.92	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	8.99	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.84	8.84	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	8.92	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.77	8.77	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	0.5	0.04	0.07	8.84	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.69	8.69	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	8.77	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.63	8.63	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	8.69	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.54	8.54	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	0.5	0.03	0.09	8.63	10.28	HGL ok
P-170	MH-170	MH-171	3.20	8.46	8.46	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	0.5	0.06	0.08	8.54	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.42	8.42	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	8.46	10.83	HGL ok
P-172	MH-172	MH-173	3.20	8.37	8.37	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	0.5	0.03	0.05	8.42	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	**0.5**	**0.03**	**0.07**	**8.37**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.46	8.46	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.46	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.46	8.46	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.46	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.42	8.42	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	8.44	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.42	8.42	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	8.43	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.47	8.47	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	8.65	10.50	HGL ok
P-179	DI-179	MH-173	1.00	8.37	8.37	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	1.3	1.0	0.09	0.10	8.47	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	8.39	8.39	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	8.43	10.50	HGL ok
P-181	DI-181	MH-173	1.00	8.37	8.37	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	1.3	1.0	0.02	0.03	8.39	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	9.26	9.26	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	9.28	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.19	9.19	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	0.5	0.03	0.07	9.26	11.99	HGL ok
P-117	DI-117	DI-118	1.20	9.11	9.11	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	9.19	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.02	9.02	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	9.11	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.82	8.82	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	9.02	11.30	HGL ok
P-114	DI-114	MH-170	1.20	8.54	8.54	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	8.82	10.75	HGL ok
P-110	B4 South	MH-111	1.20	9.09	9.09	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	9.10	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.06	9.06	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	0.5	0.01	0.03	9.09	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.02	9.02	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	1.3	1.0	0.02	0.05	9.06	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.70	8.70	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.70	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.68	8.68	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.01	8.70	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.66	8.66	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	1.3	1.0	0.01	0.02	8.68	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.63	8.63	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	0.5	0.02	0.03	8.66	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.59	8.59	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	8.63	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	8.63	8.63	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.63	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.66	8.66	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	8.68	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.67	8.67	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.67	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.65	8.65	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	8.67	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.63	8.63	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	1.3	1.0	0.01	0.02	8.65	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.61	8.61	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	0.5	0.01	0.02	8.63	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.59	8.59	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	8.61	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.54	8.54	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	0.5	0.02	0.05	8.59	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.63	8.63	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.64	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.81	8.81	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.81	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.78	8.78	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	8.81	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.71	8.71	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	8.78	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.63	8.63	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	8.71	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.81	8.81	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.82	10.00	HGL ok
P-167	DI-167	DI-159	1.00	9.06	9.06	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.06	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.00	9.00	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	9.06	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	8.99	8.99	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.00	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.92	8.92	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	8.99	10.06	HGL ok
P-153	B1	MH-151	1.60	8.99	8.99	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	9.00	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	9.04	9.04	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	9.05	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	8.95	8.95	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	8.97	10.00	HGL ok
P-163	MH-163	MH-140	1.20	8.84	8.84	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	8.95	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	9.74	9.74	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.76	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.74	9.74	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.74	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.69	9.69	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	*0.5*	0.02	0.05	9.74	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	9.62	9.62	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	9.69	11.07	HGL ok
P-152	DI-152	MH-140	2.00	9.54	9.54	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	9.62	11.07	HGL ok
P-140	MH-140	DI-141	2.40	9.47	9.47	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	*0.5*	0.04	0.07	9.54	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.39	9.39	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	9.47	11.02	HGL ok
P-142	DI-142	DI-143	2.40	9.33	9.33	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	9.39	10.52	HGL ok
P-143	DI-143	MH-170	2.40	9.24	9.24	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	*0.5*	0.03	0.09	9.33	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.16	9.16	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	*0.5*	0.06	0.08	9.24	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.12	9.12	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.05	9.16	10.83	HGL ok
P-172	MH-172	MH-173	3.20	9.07	9.07	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	*0.5*	0.03	0.05	9.12	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	***0.5***	**0.03**	**0.07**	**9.07**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	9.16	9.16	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.16	10.61	HGL ok
P-175	DI-175	MH-171	1.20	9.16	9.16	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.16	10.63	HGL ok
P-176	B4 North	MH-172	1.20	9.12	9.12	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	9.14	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.12	9.12	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	9.13	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.17	9.17	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	9.35	10.50	HGL ok
P-179	DI-179	MH-173	1.00	9.07	9.07	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	*1.3*	1.0	0.09	0.10	9.17	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.09	9.09	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	9.13	10.50	HGL ok
P-181	DI-181	MH-173	1.00	9.07	9.07	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	*1.3*	1.0	0.02	0.03	9.09	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	9.96	9.96	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	9.98	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.89	9.89	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	*0.5*	0.03	0.07	9.96	11.99	HGL ok
P-117	DI-117	DI-118	1.20	9.81	9.81	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	9.89	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.72	9.72	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	9.81	11.30	HGL ok
P-113	DI-113	DI-114	1.20	9.52	9.52	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	9.72	11.30	HGL ok
P-114	DI-114	MH-170	1.20	9.24	9.24	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	9.52	10.75	HGL ok
P-110	B4 South	MH-111	1.20	9.79	9.79	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.01	9.80	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.76	9.76	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	*0.5*	0.01	0.03	9.79	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.72	9.72	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	*1.3*	1.0	0.02	0.05	9.76	11.71	HGL ok
P-120	DI-120	DI-121	1.00	9.40	9.40	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.40	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.38	9.38	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.01	9.40	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.36	9.36	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.02	9.38	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.33	9.33	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	*0.5*	0.02	0.03	9.36	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.29	9.29	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	9.33	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.33	9.33	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.33	10.67	HGL ok
P-126	B5 North	MH-123	1.20	9.36	9.36	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	9.38	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.37	9.37	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.37	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.35	9.35	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	9.37	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.33	9.33	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.02	9.35	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.31	9.31	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	*0.5*	0.01	0.02	9.33	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.29	9.29	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	9.31	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.24	9.24	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	*0.5*	0.02	0.05	9.29	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	9.33	9.33	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	9.34	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.51	9.51	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.51	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.48	9.48	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	9.51	10.87	HGL ok
P-146	DI-146	DI-147	1.20	9.41	9.41	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	9.48	10.52	HGL ok
P-147	DI-147	DI-143	1.20	9.33	9.33	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	9.41	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	9.51	9.51	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	9.52	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	9.76	9.76	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.76	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.70	9.70	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	9.76	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.69	9.69	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.70	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	9.62	9.62	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	9.69	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.69	9.69	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	9.70	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	9.74	9.74	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	9.75	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.65	9.65	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	9.67	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.54	9.54	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	9.65	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/23 | Sheet No.: 3 of 5
County: New Castle | Checked by: TMC | Date: 3/23/23 | Cm. No.: 20077
Segment: East Bank Blvd Outfall | Design Freq.: 1 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	10.24	10.24	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.26	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.24	10.24	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.24	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.19	10.19	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	*0.5*	0.02	0.05	10.24	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.12	10.12	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	10.19	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.04	10.04	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	10.12	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	9.97	9.97	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	*0.5*	0.04	0.07	10.04	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.89	9.89	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	9.97	11.02	HGL ok
P-142	DI-142	DI-143	2.40	9.83	9.83	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	9.89	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.74	9.74	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	*0.5*	0.03	0.09	9.83	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.66	9.66	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	*0.5*	0.06	0.08	9.74	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.62	9.62	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.05	9.66	10.83	HGL ok
P-172	MH-172	MH-173	3.20	9.57	9.57	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	*0.5*	0.03	0.05	9.62	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	***0.5***	**0.03**	**0.07**	**9.57**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	9.66	9.66	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.66	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	9.66	9.66	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.66	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.62	9.62	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	9.64	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.62	9.62	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	9.63	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.67	9.67	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	9.85	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.57	9.57	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	*1.3*	1.0	0.09	0.10	9.67	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.59	9.59	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	9.63	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.57	9.57	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	*1.3*	1.0	0.02	0.03	9.59	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	10.46	10.46	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	10.48	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.39	10.39	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	*0.5*	0.03	0.07	10.46	11.99	HGL ok
P-117	DI-117	DI-118	1.20	10.31	10.31	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	10.39	11.71	HGL ok
P-118	DI-118	DI-113	1.20	10.22	10.22	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	10.31	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.02	10.02	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	10.22	11.30	HGL ok
P-114	DI-114	MH-170	1.20	9.74	9.74	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	10.02	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	10.29	10.29	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.01	10.30	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.26	10.26	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	*0.5*	0.01	0.03	10.29	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.22	10.22	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	*1.3*	1.0	0.02	0.05	10.26	11.71	HGL ok
P-120	DI-120	DI-121	1.00	9.90	9.90	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.90	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.88	9.88	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.01	9.90	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.86	9.86	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.02	9.88	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.83	9.83	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	*0.5*	0.02	0.03	9.86	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.79	9.79	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	9.83	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.83	9.83	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.83	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	9.86	9.86	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	9.88	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.87	9.87	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.87	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.85	9.85	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	9.87	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.83	9.83	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.02	9.85	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.81	9.81	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	*0.5*	0.01	0.02	9.83	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.79	9.79	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	9.81	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.74	9.74	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	*0.5*	0.02	0.05	9.79	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	9.83	9.83	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	9.84	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.01	10.01	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.01	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.98	9.98	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	10.01	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	9.91	9.91	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	9.98	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.83	9.83	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	9.91	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.01	10.01	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.02	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.26	10.26	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.26	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.20	10.20	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.26	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.19	10.19	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.20	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.12	10.12	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	10.19	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.19	10.19	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	10.20	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.24	10.24	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.25	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.15	10.15	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	10.17	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.04	10.04	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	10.15	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V$_o$^{2}/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Hi= H$_1$ +H$_2$ +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H$_f$ + H$_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	11.54	11.54	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.56	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.54	11.54	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.54	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.49	11.49	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	0.5	0.02	0.05	11.54	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.42	11.42	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	11.49	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.34	11.34	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	11.42	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.27	11.27	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	0.5	0.04	0.07	11.34	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.19	11.19	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	11.27	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.13	11.13	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	11.19	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.04	11.04	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	0.5	0.03	0.09	11.13	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.96	10.96	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	0.5	0.06	0.08	11.04	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.92	10.92	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	10.96	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.87	10.87	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	0.5	0.03	0.05	10.92	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	**0.5**	**0.03**	**0.07**	**10.87**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.96	10.96	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.96	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.96	10.96	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.96	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.92	10.92	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	10.94	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.92	10.92	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	10.93	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.97	10.97	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	11.15	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.87	10.87	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	1.3	1.0	0.09	0.10	10.97	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.89	10.89	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	10.93	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.87	10.87	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	1.3	1.0	0.02	0.03	10.89	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	11.76	11.76	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.78	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.69	11.69	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	0.5	0.03	0.07	11.76	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.61	11.61	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	11.69	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.52	11.52	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	11.61	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.32	11.32	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	11.52	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.04	11.04	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	11.32	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.59	11.59	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	11.60	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.56	11.56	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	0.5	0.01	0.03	11.59	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.52	11.52	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	1.3	1.0	0.02	0.05	11.56	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.20	11.20	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.20	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.18	11.18	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.01	11.20	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.16	11.16	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	1.3	1.0	0.01	0.02	11.18	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.13	11.13	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	0.5	0.02	0.03	11.16	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.09	11.09	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	11.13	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.13	11.13	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.13	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.16	11.16	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.18	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.17	11.17	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.17	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.15	11.15	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	11.17	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.13	11.13	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	1.3	1.0	0.01	0.02	11.15	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.11	11.11	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	0.5	0.01	0.02	11.13	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.09	11.09	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	11.11	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.04	11.04	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	0.5	0.02	0.05	11.09	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.13	11.13	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.14	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.31	11.31	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.31	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.28	11.28	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	11.31	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.21	11.21	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	11.28	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.13	11.13	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	11.21	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.31	11.31	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.32	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.56	11.56	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.56	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.50	11.50	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.56	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.49	11.49	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.50	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.42	11.42	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	11.49	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.49	11.49	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	11.50	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.54	11.54	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.55	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.45	11.45	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	11.47	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.34	11.34	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	11.45	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23
Checked by: TMC — Date: 3/23/23
Design Freq.: 1 -year (50-year for sumps)

Sheet No.: 3 of 5
Cm. No.: 20077

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D: 0.8D (ft)	Tailwater, link to Inlet WSE of downstream pipe: TW (ft)	Outlet W. S. Elevation: HGL Dn (ft)	Outflow Pipe Diameter: D_o (in)	Outflow Pipe Design Flow: Q_o (cfs)	Pressure-flow Vel., $V_o=Q_o/A$: V_o (fps)	Skew angle vs.: Δ_o (deg)	Outflow Pipe Length: L (ft)	Friction Slope: S_{fo} (ft/ft)	Friction Loss: H_f (ft)	Angle of Curvat: O (deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$: H_c (ft)	Contraction Loss: H_o (ft)	Q*V for determining controlling inflow pipe: Q1V1 (ft^4/s^2)	Q*V for determining controlling inflow pipe: Q2V2 (ft^4/s^2)	Q*V for determining controlling inflow pipe: Q3V3 (ft^4/s^2)	Controlling Inflow Velocity: Vi	Expansion Loss: Hi (ft)	Controlling In-flow skew: Δ_i (deg)	Bend Loss: H_Δ (ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$: H_t (cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss: $H_{t\,adj}$ (ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$: H (ft)	Inlet W. S. Elevation: HGL Up (ft)	Top of Grate: T/G (ft)	HGL Check
P-158	DI-158	DI-154	1.00	6.48	6.48	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.50	7.70	HGL ok
P-154	DI-154	MH-155	1.00	6.48	6.48	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.48	9.06	HGL ok
P-155	MH-155	DI-156	1.20	6.43	6.43	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	*0.5*	0.02	0.05	6.48	10.06	HGL ok
P-156	DI-156	DI-152	1.20	6.36	6.36	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	6.43	11.07	HGL ok
P-152	DI-152	MH-140	2.00	6.28	6.28	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	6.36	11.07	HGL ok
P-140	MH-140	DI-141	2.40	6.21	6.21	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	*0.5*	0.04	0.07	6.28	12.04	HGL ok
P-141	DI-141	DI-142	2.40	6.13	6.13	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	6.21	11.02	HGL ok
P-142	DI-142	DI-143	2.40	6.07	6.07	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	6.13	10.52	HGL ok
P-143	DI-143	MH-170	2.40	5.98	5.98	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	*0.5*	0.03	0.09	6.07	10.28	HGL ok
P-170	MH-170	MH-171	3.20	5.90	5.90	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	*0.5*	0.06	0.08	5.98	11.16	HGL ok
P-171	MH-171	MH-172	3.20	5.86	5.86	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.05	5.90	10.83	HGL ok
P-172	MH-172	MH-173	3.20	5.81	5.81	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	*0.5*	0.03	0.05	5.86	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	***0.5***	**0.03**	**0.07**	**5.81**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	5.90	5.90	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.90	10.61	HGL ok
P-175	DI-175	MH-171	1.20	5.90	5.90	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.90	10.63	HGL ok
P-176	B4 North	MH-172	1.20	5.86	5.86	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	5.88	10.00	HGL ok
P-177	B2 South	MH-172	1.20	5.86	5.86	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	5.87	10.00	HGL ok
P-178	TD-03	DI-179	0.53	5.91	6.23	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	6.41	10.50	HGL ok
P-179	DI-179	MH-173	1.00	5.81	5.81	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	*1.3*	1.0	0.09	0.10	5.91	9.25	HGL ok
P-180	TD-02	DI-181	0.53	5.83	6.78	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	6.82	10.50	HGL ok
P-181	DI-181	MH-173	1.00	5.81	5.81	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	*1.3*	1.0	0.02	0.03	5.83	9.25	HGL ok
P-115	B5 West	MH-116	1.20	6.70	6.70	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	6.72	10.00	HGL ok
P-116	MH-116	DI-117	1.20	6.63	6.63	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	*0.5*	0.03	0.07	6.70	11.99	HGL ok
P-117	DI-117	DI-118	1.20	6.55	6.55	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	6.63	11.71	HGL ok
P-118	DI-118	DI-113	1.20	6.46	6.46	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	6.55	11.30	HGL ok
P-113	DI-113	DI-114	1.20	6.26	6.26	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	6.46	11.30	HGL ok
P-114	DI-114	MH-170	1.20	5.98	5.98	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	6.26	10.75	HGL ok
P-110	B4 South	MH-111	1.20	6.53	6.53	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.01	6.54	10.00	HGL ok
P-111	MH-111	DI-112	1.20	6.50	6.50	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	*0.5*	0.01	0.03	6.53	11.99	HGL ok
P-112	DI-112	DI-113	1.20	6.46	6.46	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	*1.3*	1.0	0.02	0.05	6.50	11.71	HGL ok
P-120	DI-120	DI-121	1.00	6.14	6.14	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.14	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	6.12	6.12	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.01	6.14	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	6.10	6.10	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.02	6.12	7.81	HGL ok
P-123	MH-123	DI-124	1.60	6.07	6.07	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	*0.5*	0.02	0.03	6.10	8.91	HGL ok
P-124	DI-124	MH-135	1.60	6.03	6.03	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	6.07	9.44	HGL ok
P-125	DI-125	DI-124	1.00	6.07	6.07	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.07	10.67	HGL ok
P-126	B5 North	MH-123	1.20	6.10	6.10	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	6.12	10.00	HGL ok
P-130	DI-130	DI-131	1.00	6.11	6.11	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.11	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	6.09	6.09	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	6.11	7.15	HGL ok
P-132	DI-132	MH-133	1.00	6.07	6.07	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.02	6.09	7.81	HGL ok
P-133	MH-133	DI-134	1.60	6.05	6.05	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	*0.5*	0.01	0.02	6.07	8.91	HGL ok
P-134	DI-134	MH-135	1.60	6.03	6.03	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	6.05	9.44	HGL ok
P-135	MH-135	MH-170	2.00	5.98	5.98	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	*0.5*	0.02	0.05	6.03	10.15	HGL ok
P-136	B3 South	MH-133	1.20	6.07	6.07	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	6.08	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	6.25	6.25	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.25	11.02	HGL ok
P-145	MH-145	DI-146	1.20	6.22	6.22	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	6.25	10.87	HGL ok
P-146	DI-146	DI-147	1.20	6.15	6.15	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	6.22	10.52	HGL ok
P-147	DI-147	DI-143	1.20	6.07	6.07	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	6.15	10.28	HGL ok
P-148	B3 West	MH-145	1.20	6.25	6.25	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	6.26	10.00	HGL ok
P-167	DI-167	DI-159	1.00	6.50	6.50	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.50	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	6.44	6.44	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	6.50	7.70	HGL ok
P-150	DI-150	MH-151	1.00	6.43	6.43	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.44	9.06	HGL ok
P-151	MH-151	DI-152	1.60	6.36	6.36	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	6.43	10.06	HGL ok
P-153	B1	MH-151	1.60	6.43	6.43	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	6.44	10.00	HGL ok
P-157	B3 North	MH-155	1.20	6.48	6.48	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	6.49	10.00	HGL ok
P-166	B2 North	MH-163	1.20	6.39	6.39	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	6.41	10.00	HGL ok
P-163	MH-163	MH-140	1.20	6.28	6.28	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	6.39	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 1 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	6.68	6.68	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.70	7.70	HGL ok
P-154	DI-154	MH-155	1.00	6.68	6.68	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.68	9.06	HGL ok
P-155	MH-155	DI-156	1.20	6.63	6.63	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	*0.5*	0.02	0.05	6.68	10.06	HGL ok
P-156	DI-156	DI-152	1.20	6.56	6.56	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	6.63	11.07	HGL ok
P-152	DI-152	MH-140	2.00	6.48	6.48	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	6.56	11.07	HGL ok
P-140	MH-140	DI-141	2.40	6.41	6.41	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	*0.5*	0.04	0.07	6.48	12.04	HGL ok
P-141	DI-141	DI-142	2.40	6.33	6.33	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	6.41	11.02	HGL ok
P-142	DI-142	DI-143	2.40	6.27	6.27	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	6.33	10.52	HGL ok
P-143	DI-143	MH-170	2.40	6.18	6.18	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	*0.5*	0.03	0.09	6.27	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.10	6.10	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	*0.5*	0.06	0.08	6.18	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.06	6.06	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.05	6.10	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.01	6.01	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	*0.5*	0.03	0.05	6.06	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	***0.5***	**0.03**	**0.07**	**6.01**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.10	6.10	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.10	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.10	6.10	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.10	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.06	6.06	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	6.08	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.06	6.06	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	6.07	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.11	6.23	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	6.41	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.01	6.01	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	*1.3*	1.0	0.09	0.10	6.11	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.03	6.78	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	6.82	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.01	6.01	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	*1.3*	1.0	0.02	0.03	6.03	9.25	HGL ok
P-115	B5 West	MH-116	1.20	6.90	6.90	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	6.92	10.00	HGL ok
P-116	MH-116	DI-117	1.20	6.83	6.83	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	*0.5*	0.03	0.07	6.90	11.99	HGL ok
P-117	DI-117	DI-118	1.20	6.75	6.75	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	6.83	11.71	HGL ok
P-118	DI-118	DI-113	1.20	6.66	6.66	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	6.75	11.30	HGL ok
P-113	DI-113	DI-114	1.20	6.46	6.46	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	6.66	11.30	HGL ok
P-114	DI-114	MH-170	1.20	6.18	6.18	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	6.46	10.75	HGL ok
P-110	B4 South	MH-111	1.20	6.73	6.73	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.01	6.74	10.00	HGL ok
P-111	MH-111	DI-112	1.20	6.70	6.70	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	*0.5*	0.01	0.03	6.73	11.99	HGL ok
P-112	DI-112	DI-113	1.20	6.66	6.66	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	*1.3*	1.0	0.02	0.05	6.70	11.71	HGL ok
P-120	DI-120	DI-121	1.00	6.34	6.34	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.34	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	6.32	6.32	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.01	6.34	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	6.30	6.30	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.02	6.32	7.81	HGL ok
P-123	MH-123	DI-124	1.60	6.27	6.27	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	*0.5*	0.02	0.03	6.30	8.91	HGL ok
P-124	DI-124	MH-135	1.60	6.23	6.23	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	6.27	9.44	HGL ok
P-125	DI-125	DI-124	1.00	6.27	6.27	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.27	10.67	HGL ok
P-126	B5 North	MH-123	1.20	6.30	6.30	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	6.32	10.00	HGL ok
P-130	DI-130	DI-131	1.00	6.31	6.31	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.31	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	6.29	6.29	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	6.31	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	6.27	6.27	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.02	6.29	7.81	HGL ok
P-133	MH-133	DI-134	1.60	6.25	6.25	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	*0.5*	0.01	0.02	6.27	8.91	HGL ok
P-134	DI-134	MH-135	1.60	6.23	6.23	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	6.25	9.44	HGL ok
P-135	MH-135	MH-170	2.00	6.18	6.18	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	*0.5*	0.02	0.05	6.23	10.15	HGL ok
P-136	B3 South	MH-133	1.20	6.27	6.27	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	6.28	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	6.45	6.45	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.45	11.02	HGL ok
P-145	MH-145	DI-146	1.20	6.42	6.42	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	6.45	10.87	HGL ok
P-146	DI-146	DI-147	1.20	6.35	6.35	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	6.42	10.52	HGL ok
P-147	DI-147	DI-143	1.20	6.27	6.27	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	6.35	10.28	HGL ok
P-148	B3 West	MH-145	1.20	6.45	6.45	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	6.46	10.00	HGL ok
P-167	DI-167	DI-159	1.00	6.70	6.70	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.70	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	6.64	6.64	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	6.70	7.70	HGL ok
P-150	DI-150	MH-151	1.00	6.63	6.63	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.64	9.06	HGL ok
P-151	MH-151	DI-152	1.60	6.56	6.56	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	6.63	10.06	HGL ok
P-153	B1	MH-151	1.60	6.63	6.63	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	6.64	10.00	HGL ok
P-157	B3 North	MH-155	1.20	6.68	6.68	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	6.69	10.00	HGL ok
P-166	B2 North	MH-163	1.20	6.59	6.59	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	6.61	10.00	HGL ok
P-163	MH-163	MH-140	1.20	6.48	6.48	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	6.59	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 1 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Cm. No.: 20077

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	10.18	10.18	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.20	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.18	10.18	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.18	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.13	10.13	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	*0.5*	0.02	0.05	10.18	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.06	10.06	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	10.13	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	9.98	9.98	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	10.06	11.07	HGL ok
P-140	MH-140	DI-141	2.40	9.91	9.91	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	*0.5*	0.04	0.07	9.98	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.83	9.83	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	9.91	11.02	HGL ok
P-142	DI-142	DI-143	2.40	9.77	9.77	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	9.83	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.68	9.68	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	*0.5*	0.03	0.09	9.77	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.60	9.60	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	*0.5*	0.06	0.08	9.68	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.56	9.56	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.05	9.60	10.83	HGL ok
P-172	MH-172	MH-173	3.20	9.51	9.51	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	*0.5*	0.03	0.05	9.56	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	***0.5***	**0.03**	**0.07**	**9.51**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	9.60	9.60	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.60	10.61	HGL ok
P-175	DI-175	MH-171	1.20	9.60	9.60	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.60	10.63	HGL ok
P-176	B4 North	MH-172	1.20	9.56	9.56	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	9.58	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.56	9.56	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	9.57	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.61	9.61	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	9.79	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.51	9.51	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	*1.3*	1.0	0.09	0.10	9.61	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.53	9.53	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	9.57	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.51	9.51	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	*1.3*	1.0	0.02	0.03	9.53	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	10.40	10.40	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	10.42	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.33	10.33	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	*0.5*	0.03	0.07	10.40	11.99	HGL ok
P-117	DI-117	DI-118	1.20	10.25	10.25	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	10.33	11.71	HGL ok
P-118	DI-118	DI-113	1.20	10.16	10.16	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	10.25	11.30	HGL ok
P-113	DI-113	DI-114	1.20	9.96	9.96	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	10.16	11.30	HGL ok
P-114	DI-114	MH-170	1.20	9.68	9.68	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	9.96	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	10.23	10.23	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.01	10.24	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.20	10.20	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	*0.5*	0.01	0.03	10.23	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.16	10.16	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	*1.3*	1.0	0.02	0.05	10.20	11.71	HGL ok
P-120	DI-120	DI-121	1.00	9.84	9.84	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.84	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.82	9.82	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.01	9.84	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.80	9.80	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.02	9.82	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.77	9.77	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	*0.5*	0.02	0.03	9.80	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.73	9.73	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	9.77	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.77	9.77	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.77	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	9.80	9.80	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	9.82	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.81	9.81	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.81	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.79	9.79	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	9.81	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.77	9.77	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.02	9.79	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.75	9.75	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	*0.5*	0.01	0.02	9.77	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.73	9.73	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	9.75	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.68	9.68	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	*0.5*	0.02	0.05	9.73	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	9.77	9.77	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	9.78	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.95	9.95	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.95	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.92	9.92	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	9.95	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	9.85	9.85	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	9.92	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.77	9.77	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	9.85	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	9.95	9.95	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	9.96	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.20	10.20	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.20	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.14	10.14	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.20	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.13	10.13	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.14	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.06	10.06	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	10.13	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.13	10.13	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	10.14	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.18	10.18	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.19	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.09	10.09	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	10.11	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.98	9.98	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	10.09	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 1 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	10.68	10.68	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.70	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.68	10.68	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.68	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.63	10.63	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	0.5	0.02	0.05	10.68	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.56	10.56	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	10.63	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.48	10.48	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	10.56	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.41	10.41	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	0.5	0.04	0.07	10.48	12.04	HGL ok
P-141	DI-141	DI-142	2.40	10.33	10.33	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	10.41	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.27	10.27	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	10.33	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.18	10.18	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	0.5	0.03	0.09	10.27	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.10	10.10	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	0.5	0.06	0.08	10.18	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.06	10.06	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	10.10	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.01	10.01	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	0.5	0.03	0.05	10.06	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	**0.5**	**0.03**	**0.07**	**10.01**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.10	10.10	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.10	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.10	10.10	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.10	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.06	10.06	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	10.08	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.06	10.06	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	10.07	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.11	10.11	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	10.29	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.01	10.01	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	1.3	1.0	0.09	0.10	10.11	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.03	10.03	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	10.07	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.01	10.01	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	1.3	1.0	0.02	0.03	10.03	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	10.90	10.90	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.92	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.83	10.83	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	0.5	0.03	0.07	10.90	11.99	HGL ok
P-117	DI-117	DI-118	1.20	10.75	10.75	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	10.83	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	10.66	10.66	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	10.75	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.46	10.46	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	10.66	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.18	10.18	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	10.46	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	10.73	10.73	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	10.74	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.70	10.70	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	0.5	0.01	0.03	10.73	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.66	10.66	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	1.3	1.0	0.02	0.05	10.70	11.71	HGL ok
P-120	DI-120	DI-121	1.00	10.34	10.34	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.34	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.32	10.32	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.01	10.34	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.30	10.30	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	1.3	1.0	0.01	0.02	10.32	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.27	10.27	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	0.5	0.02	0.03	10.30	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.23	10.23	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	10.27	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.27	10.27	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.27	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.30	10.30	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.32	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.31	10.31	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.31	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.29	10.29	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	10.31	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.27	10.27	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	1.3	1.0	0.01	0.02	10.29	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.25	10.25	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	0.5	0.01	0.02	10.27	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.23	10.23	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	10.25	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.18	10.18	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	0.5	0.02	0.05	10.23	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.27	10.27	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.28	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.45	10.45	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.45	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.42	10.42	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	10.45	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.35	10.35	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	10.42	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.27	10.27	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	10.35	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.45	10.45	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.46	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.70	10.70	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.70	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.64	10.64	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.70	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.63	10.63	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.64	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.56	10.56	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	10.63	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.63	10.63	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	10.64	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.68	10.68	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.69	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.59	10.59	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	10.61	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.48	10.48	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	10.59	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)		

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	11.08	11.08	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.10	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.08	11.08	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.08	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.03	11.03	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	0.5	0.02	0.05	11.08	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.96	10.96	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	11.03	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.88	10.88	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	10.96	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.81	10.81	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	0.5	0.04	0.07	10.88	12.04	HGL ok
P-141	DI-141	DI-142	2.40	10.73	10.73	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	10.81	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.67	10.67	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	10.73	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.58	10.58	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	0.5	0.03	0.09	10.67	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.50	10.50	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	0.5	0.06	0.08	10.58	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.46	10.46	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	10.50	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.41	10.41	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	0.5	0.03	0.05	10.46	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	**0.5**	**0.03**	**0.07**	**10.41**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.50	10.50	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.50	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.50	10.50	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.50	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.46	10.46	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	10.48	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.46	10.46	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	10.47	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.51	10.51	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	10.69	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.41	10.41	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	1.3	1.0	0.09	0.10	10.51	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.43	10.43	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	10.47	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.41	10.41	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	1.3	1.0	0.02	0.03	10.43	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	11.30	11.30	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.32	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.23	11.23	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	0.5	0.03	0.07	11.30	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.15	11.15	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	11.23	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.06	11.06	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	11.15	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.86	10.86	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	11.06	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.58	10.58	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	10.86	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.13	11.13	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	11.14	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.10	11.10	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	0.5	0.01	0.03	11.13	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.06	11.06	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	1.3	1.0	0.02	0.05	11.10	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.74	10.74	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.74	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.72	10.72	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.01	10.74	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.70	10.70	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	1.3	1.0	0.01	0.02	10.72	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.67	10.67	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	0.5	0.02	0.03	10.70	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.63	10.63	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	10.67	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.67	10.67	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.67	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.70	10.70	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.72	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.71	10.71	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.71	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.69	10.69	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	10.71	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.67	10.67	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	1.3	1.0	0.01	0.02	10.69	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.65	10.65	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	0.5	0.01	0.02	10.67	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.63	10.63	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	10.65	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.58	10.58	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	0.5	0.02	0.05	10.63	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.67	10.67	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.68	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.85	10.85	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.85	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.82	10.82	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	10.85	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.75	10.75	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	10.82	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.67	10.67	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	10.75	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.85	10.85	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.86	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.10	11.10	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.10	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.04	11.04	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.10	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.03	11.03	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.04	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.96	10.96	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	11.03	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.03	11.03	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	11.04	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.08	11.08	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.09	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.99	10.99	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	11.01	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.88	10.88	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	10.99	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	11.58	11.58	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.60	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.58	11.58	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.58	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.53	11.53	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	0.5	0.02	0.05	11.58	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.46	11.46	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	11.53	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.38	11.38	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	11.46	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.31	11.31	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	0.5	0.04	0.07	11.38	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.23	11.23	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	11.31	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.17	11.17	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	11.23	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.08	11.08	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	0.5	0.03	0.09	11.17	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.00	11.00	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	0.5	0.06	0.08	11.08	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.96	10.96	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	11.00	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.91	10.91	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	0.5	0.03	0.05	10.96	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	**0.5**	**0.03**	**0.07**	**10.91**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.00	11.00	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.00	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.00	11.00	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.00	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.96	10.96	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	10.98	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.96	10.96	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	10.97	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.01	11.01	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	11.19	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.91	10.91	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	1.3	1.0	0.09	0.10	11.01	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.93	10.93	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	10.97	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.91	10.91	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	1.3	1.0	0.02	0.03	10.93	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	11.80	11.80	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.82	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.73	11.73	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	0.5	0.03	0.07	11.80	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.65	11.65	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	11.73	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.56	11.56	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	11.65	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.36	11.36	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	11.56	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.08	11.08	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	11.36	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.63	11.63	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	11.64	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.60	11.60	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	0.5	0.01	0.03	11.63	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.56	11.56	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	1.3	1.0	0.02	0.05	11.60	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.24	11.24	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.24	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.22	11.22	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.01	11.24	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.20	11.20	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	1.3	1.0	0.01	0.02	11.22	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.17	11.17	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	0.5	0.02	0.03	11.20	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.13	11.13	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	11.17	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.17	11.17	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.17	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.20	11.20	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.22	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.21	11.21	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.21	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.19	11.19	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	11.21	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.17	11.17	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	1.3	1.0	0.01	0.02	11.19	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.15	11.15	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	0.5	0.01	0.02	11.17	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.13	11.13	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	11.15	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.08	11.08	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	0.5	0.02	0.05	11.13	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.17	11.17	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.18	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.35	11.35	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.35	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.32	11.32	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	11.35	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.25	11.25	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	11.32	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.17	11.17	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	11.25	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.35	11.35	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.36	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.60	11.60	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.60	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.54	11.54	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.60	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.53	11.53	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.54	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.46	11.46	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	11.53	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.53	11.53	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	11.54	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.58	11.58	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.59	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.49	11.49	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	11.51	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.38	11.38	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	11.49	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)		

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta+H_c$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.28	12.28	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.30	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.28	12.28	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.28	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.23	12.23	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	*0.5*	0.02	0.05	12.28	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.16	12.16	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	12.23	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.08	12.08	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	12.16	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.01	12.01	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	*0.5*	0.04	0.07	12.08	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.93	11.93	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	12.01	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.87	11.87	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	11.93	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.78	11.78	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	*0.5*	0.03	0.09	11.87	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.70	11.70	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	*0.5*	0.06	0.08	11.78	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.66	11.66	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.05	11.70	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.61	11.61	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	*0.5*	0.03	0.05	11.66	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	***0.5***	**0.03**	**0.07**	**11.61**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.70	11.70	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.70	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.70	11.70	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.70	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.66	11.66	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	11.68	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.66	11.66	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	11.67	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.71	11.71	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	11.89	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.61	11.61	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	*1.3*	1.0	0.09	0.10	11.71	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.63	11.63	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	11.67	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.61	11.61	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	*1.3*	1.0	0.02	0.03	11.63	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.50	12.50	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	12.52	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.43	12.43	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	*0.5*	0.03	0.07	12.50	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.35	12.35	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	12.43	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.26	12.26	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	12.35	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.06	12.06	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	12.26	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.78	11.78	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	12.06	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.33	12.33	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.01	12.34	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.30	12.30	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	*0.5*	0.01	0.03	12.33	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.26	12.26	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	*1.3*	1.0	0.02	0.05	12.30	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.94	11.94	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.94	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.92	11.92	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.01	11.94	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.90	11.90	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.02	11.92	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.87	11.87	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	*0.5*	0.02	0.03	11.90	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.83	11.83	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	11.87	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.87	11.87	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.87	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.90	11.90	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	11.92	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.91	11.91	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.91	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.89	11.89	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	11.91	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.87	11.87	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.02	11.89	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.85	11.85	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	*0.5*	0.01	0.02	11.87	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.83	11.83	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	11.85	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.78	11.78	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	*0.5*	0.02	0.05	11.83	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.87	11.87	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	11.88	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.05	12.05	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.05	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.02	12.02	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	12.05	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.95	11.95	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	12.02	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.87	11.87	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	11.95	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.05	12.05	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	12.06	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.30	12.30	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.30	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.24	12.24	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.30	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.23	12.23	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.24	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.16	12.16	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	12.23	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.23	12.23	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	12.24	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.28	12.28	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	12.29	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.19	12.19	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	12.21	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.08	12.08	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	12.19	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 1 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.78	12.78	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.80	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.78	12.78	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.78	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.73	12.73	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	*0.5*	0.02	0.05	12.78	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.66	12.66	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	12.73	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.58	12.58	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	12.66	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.51	12.51	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	*0.5*	0.04	0.07	12.58	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.43	12.43	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	12.51	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.37	12.37	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	12.43	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.28	12.28	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	*0.5*	0.03	0.09	12.37	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.20	12.20	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	*0.5*	0.06	0.08	12.28	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	12.16	12.16	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.05	12.20	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	12.11	12.11	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	*0.5*	0.03	0.05	12.16	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	***0.5***	**0.03**	**0.07**	**12.11**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.20	12.20	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.20	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.20	12.20	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.20	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	12.16	12.16	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	12.18	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	12.16	12.16	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.02	12.17	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.21	12.21	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	12.39	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	12.11	12.11	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	*1.3*	1.0	0.09	0.10	12.21	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	12.13	12.13	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	12.17	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	12.11	12.11	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	*1.3*	1.0	0.02	0.03	12.13	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.00	13.00	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	13.02	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.93	12.93	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	*0.5*	0.03	0.07	13.00	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.85	12.85	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	12.93	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.76	12.76	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	12.85	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.56	12.56	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	12.76	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.28	12.28	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	12.56	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.83	12.83	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	*0.5*	0.00	0.01	12.84	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.80	12.80	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	*0.5*	0.01	0.03	12.83	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.76	12.76	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	*1.3*	1.0	0.02	0.05	12.80	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.44	12.44	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.44	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.42	12.42	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.01	12.44	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.40	12.40	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.02	12.42	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.37	12.37	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	*0.5*	0.02	0.03	12.40	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.33	12.33	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	12.37	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.37	12.37	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.37	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.40	12.40	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	12.42	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.41	12.41	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.41	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.39	12.39	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	12.41	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.37	12.37	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.02	12.39	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.35	12.35	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	*0.5*	0.01	0.02	12.37	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.33	12.33	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	12.35	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.28	12.28	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	*0.5*	0.02	0.05	12.33	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.37	12.37	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	12.38	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.55	12.55	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.55	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.52	12.52	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	12.55	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.45	12.45	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	12.52	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.37	12.37	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	12.45	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.55	12.55	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	12.56	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.80	12.80	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.80	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.74	12.74	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.80	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.73	12.73	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.74	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.66	12.66	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	12.73	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.73	12.73	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	12.74	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.78	12.78	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	12.79	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.69	12.69	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	12.71	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.58	12.58	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	12.69	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 1 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	14.08	14.08	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.10	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	14.08	14.08	15	0.6	0.5	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.08	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	14.03	14.03	18	2.7	1.5	89	51	0.0006	0.03	0	0.00	0.01	0.3	2.6	0.0	1.2	0.0	89	0.02	0.03	1.0	0.5	0.02	0.05	14.08	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.96	13.96	18	2.9	1.6	94	33	0.0007	0.02	0	0.00	0.01	4.2	0.0	0.0	1.5	0.0	89	0.03	0.05	1.0	1.0	0.05	0.07	14.03	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	13.88	13.88	30	9.3	1.9	85	97	0.0004	0.04	0	0.00	0.01	4.8	13.0	0.0	2.0	0.0	3	0.01	0.04	1.0	1.0	0.04	0.09	13.96	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	13.81	13.81	36	13.9	2.0	2	97	0.0004	0.04	0	0.00	0.01	17.7	13.9	0.0	1.9	0.0	85	0.04	0.07	1.0	0.5	0.04	0.07	13.88	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	13.73	13.73	36	14.0	2.0	1	96	0.0004	0.04	0	0.00	0.02	27.3	0.0	0.0	2.0	0.0	2	0.00	0.04	1.0	1.0	0.04	0.07	13.81	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	13.67	13.67	36	14.1	2.0	5	68	0.0004	0.03	0	0.00	0.02	27.6	0.0	0.0	2.0	0.0	1	0.00	0.04	1.0	1.0	0.04	0.06	13.73	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	13.58	13.58	36	17.3	2.4	86	115	0.0006	0.07	0	0.00	0.02	28.1	5.2	0.0	2.0	0.0	5	0.01	0.05	1.0	0.5	0.03	0.09	13.67	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	13.50	13.50	48	29.8	2.4	0	55	0.0004	0.02	0	0.00	0.02	42.1	19.5	11.9	2.4	0.0	86	0.06	0.12	1.0	0.5	0.06	0.08	13.58	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	13.46	13.46	48	30.1	2.4	0	50	0.0004	0.02	0	0.00	0.02	70.6	0.1	0.1	2.4	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	13.50	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	13.41	13.41	48	33.4	2.7	0	44	0.0005	0.02	0	0.00	0.03	72.2	2.2	2.1	2.4	0.0	0	0.00	0.06	1.0	0.5	0.03	0.05	13.46	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**35.3**	**2.8**	**0**	**64**	**0.0005**	**0.03**	**0**	**0.00**	**0.03**	**88.8**	**1.5**	**0.7**	**2.7**	**0.0**	**0**	**0.00**	**0.07**	**1.0**	**0.5**	**0.03**	**0.07**	**13.41**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	13.50	13.50	18	0.3	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.50	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	13.50	13.50	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.50	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	13.46	13.46	18	2.0	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	13.48	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	13.46	13.46	18	1.9	1.1	90	55	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	13.47	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	13.51	13.51	8	0.8	2.2	56	56	0.0028	0.16	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.18	13.69	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	13.41	13.41	15	1.4	1.1	90	30	0.0004	0.01	0	0.00	0.00	1.7	0.0	0.0	2.2	0.0	56	0.04	0.07	1.3	1.0	0.09	0.10	13.51	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	13.43	13.43	8	0.4	1.0	45	45	0.0006	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	13.47	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	13.41	13.41	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	1.0	0.0	45	0.01	0.02	1.3	1.0	0.02	0.03	13.43	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.30	14.30	18	2.9	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	14.32	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.23	14.23	18	2.9	1.7	4	60	0.0007	0.04	0	0.00	0.01	4.9	0.0	0.0	1.7	0.0	86	0.03	0.05	1.0	0.5	0.03	0.07	14.30	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.15	14.15	18	3.1	1.8	89	71	0.0008	0.05	0	0.00	0.01	4.8	0.0	0.0	1.7	0.0	4	0.00	0.03	1.0	1.0	0.03	0.09	14.23	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	14.06	14.06	18	3.4	1.9	72	27	0.0009	0.02	0	0.00	0.01	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.0	1.0	0.07	0.09	14.15	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.86	13.86	18	5.8	3.3	25	41	0.0026	0.11	0	0.00	0.04	6.4	2.8	0.0	1.9	0.0	72	0.03	0.10	1.0	1.0	0.10	0.20	14.06	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	13.58	13.58	18	5.9	3.3	97	47	0.0027	0.13	0	0.00	0.04	18.8	0.0	0.0	3.3	0.1	25	0.05	0.15	1.0	1.0	0.15	0.28	13.86	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.13	14.13	18	2.0	1.1	86	17	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	14.14	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.10	14.10	18	2.0	1.1	4	60	0.0003	0.02	0	0.00	0.00	2.2	0.0	0.0	1.1	0.0	86	0.01	0.03	1.0	0.5	0.01	0.03	14.13	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	14.06	14.06	18	2.2	1.3	19	71	0.0004	0.03	0	0.00	0.01	2.2	0.0	0.0	1.1	0.0	4	0.00	0.01	1.3	1.0	0.02	0.05	14.10	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	13.74	13.74	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.74	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	13.72	13.72	15	0.7	0.6	7	84	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.01	13.74	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	13.70	13.70	15	1.1	0.9	14	56	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	7	0.00	0.01	1.3	1.0	0.01	0.02	13.72	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	13.67	13.67	24	3.9	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.0	4.8	0.0	1.6	0.0	81	0.03	0.05	1.0	0.5	0.02	0.03	13.70	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	13.63	13.63	24	4.3	1.4	90	31	0.0003	0.01	0	0.00	0.01	4.8	0.0	0.0	1.2	0.0	81	0.02	0.03	1.0	1.0	0.03	0.04	13.67	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	13.67	13.67	15	0.1	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.67	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	13.70	13.70	18	2.9	1.6	81	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	13.72	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	13.71	13.71	15	0.2	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.71	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	13.69	13.69	15	0.7	0.6	5	83	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	13.71	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	13.67	13.67	15	1.1	0.9	14	56	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	5	0.00	0.01	1.3	1.0	0.01	0.02	13.69	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	13.65	13.65	24	3.1	1.0	81	36	0.0002	0.01	0	0.00	0.00	1.0	2.6	0.0	1.2	0.0	81	0.02	0.03	1.0	0.5	0.01	0.02	13.67	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	13.63	13.63	24	3.5	1.1	90	31	0.0002	0.01	0	0.00	0.00	3.1	0.0	0.0	1.0	0.0	81	0.01	0.02	1.0	1.0	0.02	0.03	13.65	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	13.58	13.58	30	7.7	1.6	0	94	0.0003	0.03	0	0.00	0.01	3.8	5.8	0.0	1.4	0.0	90	0.02	0.04	1.0	0.5	0.02	0.05	13.63	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	13.67	13.67	18	2.1	1.2	81	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	13.68	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	13.85	13.85	15	0.2	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.85	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.82	13.82	18	2.3	1.3	7	39	0.0004	0.02	0	0.00	0.01	0.0	2.6	0.0	1.2	0.0	83	0.02	0.03	1.0	0.5	0.02	0.03	13.85	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	13.75	13.75	18	2.6	1.5	89	68	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	7	0.00	0.02	1.3	1.0	0.03	0.06	13.82	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	13.67	13.67	18	3.0	1.7	86	25	0.0007	0.02	0	0.00	0.01	3.9	0.0	0.0	1.5	0.0	89	0.02	0.05	1.3	1.0	0.06	0.08	13.75	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	13.85	13.85	18	2.1	1.2	83	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	13.86	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	14.10	14.10	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.10	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	14.04	14.04	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	14.10	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	14.03	14.03	15	1.0	0.8	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.04	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.96	13.96	24	6.4	2.0	3	51	0.0007	0.03	0	0.00	0.02	0.9	9.3	0.0	1.7	0.0	89	0.03	0.06	1.0	0.5	0.03	0.07	14.03	10.06	HGL Too High!
P-153	B1	MH-151	1.60	14.03	14.03	24	5.4	1.7	89	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.01	14.04	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	14.08	14.08	18	2.1	1.2	89	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	14.09	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.99	13.99	18	1.9	1.1	90	50	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.02	14.01	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.88	13.88	18	4.9	2.8	92	44	0.0019	0.08	0	0.00	0.03	2.0	0.0	2.0	1.1	0.0	90	0.01	0.05	1.3	0.5	0.03	0.12	13.99	10.50	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 2	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-158	DI-158	DI-154	3887	225	4112	0.09	0.91	0.09	0.09	6.0	0.00	4.01	**0.34**	15	100	0.012	0.000024	0.0053	4.2	**5.1**	2.0	0.82	6.82	**4.36**	3.83	Q ok
P-154	DI-154	MH-155	3023	31	3054	0.07	0.94	0.07	0.15	6.0	6.82	4.61	**0.70**	15	24	0.012	0.000100	0.0042	3.7	**4.5**	2.6	0.16	6.97	**3.73**	3.63	Q ok
P-155	MH-155	DI-156	1	0	1	0.00	0.95	0.00	0.69	6.0	6.97	4.57	**3.14**	18	51	0.012	0.000763	0.0039	4.0	**7.1**	3.9	0.22	7.19	3.53	3.33	Q ok
P-156	DI-156	DI-152	2725	0	2725	0.06	0.95	0.06	0.75	6.0	7.19	4.53	**3.38**	18	33	0.012	0.000884	0.0039	4.0	**7.1**	3.9	0.14	7.33	3.23	3.10	Q ok
P-152	DI-152	MH-140	3517	0	3517	0.08	0.95	0.08	2.41	6.0	7.33	4.51	**10.86**	**30**	97	0.012	0.000597	0.0040	5.7	**28.2**	5.3	0.31	7.64	3.00	2.61	Q ok
P-140	MH-140	DI-141	1	0	1	0.00	0.95	0.00	3.65	6.0	7.64	4.45	**16.25**	36	97	0.012	0.000506	0.0040	6.5	**45.8**	5.8	0.28	7.92	2.51	2.12	Q ok
P-141	DI-141	DI-142	3263	65	3328	0.08	0.93	0.07	3.72	6.0	7.92	4.39	**16.34**	36	96	0.012	0.000512	0.0040	6.4	**45.5**	5.8	0.28	8.19	2.02	1.64	Q ok
P-142	DI-142	DI-143	3699	195	3894	0.09	0.91	0.08	3.80	6.0	8.19	4.33	**16.47**	36	68	0.012	0.000520	0.0040	6.4	**45.5**	5.8	0.20	8.39	1.54	1.27	Q ok
P-143	DI-143	MH-170	5428	266	5694	0.13	0.91	0.12	4.71	6.0	8.39	4.29	**20.22**	36	115	0.012	0.000783	0.0040	6.5	**45.7**	6.3	0.31	8.69	1.17	0.71	Q ok
P-170	MH-170	MH-171	1	0	1	0.00	0.95	0.00	8.26	6.0	8.69	4.23	**34.96**	48	55	0.012	0.000505	0.0040	7.8	**98.4**	7.0	0.13	8.82	0.61	0.39	Q ok
P-171	MH-171	MH-172	1	0	1	0.00	0.95	0.00	8.44	6.0	8.82	4.21	**35.52**	48	50	0.012	0.000521	0.0040	7.8	**98.4**	7.0	0.12	8.94	0.29	0.09	Q ok
P-172	MH-172	MH-173	1	0	1	0.00	0.95	0.00	9.41	6.0	8.94	4.19	**39.42**	48	44	0.012	0.000642	0.0041	7.9	**99.5**	7.3	0.10	9.04	-0.01	-0.19	Q ok
P-173	MH-173	OUTFALL	1	0	1	0.00	0.95	0.00	9.98	6.0	9.04	4.17	**41.64**	**48**	64	0.012	0.000716	0.0041	7.9	**99.2**	7.3	0.15	9.19	-0.29	**-0.55**	Q ok
P-174	DI-174	MH-171	3578	530	4108	0.09	0.85	0.08	0.08	6.0	0.00	4.77	**0.38**	18	33	0.012	0.000011	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-175	DI-175	MH-171	4118	530	4648	0.11	0.86	0.09	0.09	6.0	0.00	4.77	**0.44**	18	33	0.012	0.000015	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-176	B4 North	MH-172	22780	0	22780	0.52	0.95	0.50	0.50	6.0	0.00	4.77	**2.37**	18	55	0.012	0.000434	0.0049	4.5	**8.0**	3.8	0.24	6.24	1.26	0.99	Q ok
P-177	B2 South	MH-172	21809	0	21809	0.50	0.95	0.48	0.48	6.0	0.00	4.77	**2.27**	18	55	0.012	0.000397	0.0049	4.5	**8.0**	3.8	0.24	6.24	1.26	0.99	Q ok
P-178	TD-03	DI-179	8687	0	8687	0.20	0.95	0.19	0.19	6.0	0.00	4.77	**0.90**	8	56	0.011	0.004004	0.0509	9.2	**3.2**	7.8	0.12	6.12	8.55	5.70	Q ok
P-179	DI-179	MH-173	6306	3055	9361	0.21	0.70	0.15	0.34	6.0	6.12	4.75	**1.61**	15	30	0.012	0.000531	0.0500	12.8	**15.6**	7.7	0.07	6.18	3.21	1.71	Q ok
P-180	TD-02	DI-181	4084	0	4084	0.09	0.95	0.09	0.09	6.0	0.00	4.77	**0.42**	8	45	0.011	0.000885	0.0500	9.1	**3.2**	6.4	0.12	6.12	8.50	6.25	Q ok
P-181	DI-181	MH-173	6222	2906	9128	0.21	0.70	0.15	0.24	6.0	6.12	4.75	**1.12**	15	30	0.012	0.000258	0.0500	12.8	**15.6**	6.2	0.08	6.20	3.21	1.71	Q ok
P-115	B5 West	MH-116	33468	0	33468	0.77	0.95	0.73	0.73	6.0	0.00	4.77	**3.48**	18	17	0.012	0.000936	0.0047	4.4	**7.8**	4.3	0.07	6.07	3.84	3.76	Q ok
P-116	MH-116	DI-117	1	0	1	0.00	0.95	0.00	0.73	6.0	6.07	4.75	**3.47**	18	60	0.012	0.000928	0.0050	4.6	**8.0**	4.4	0.23	6.29	3.66	3.36	Q ok
P-117	DI-117	DI-118	2919	167	3086	0.07	0.91	0.06	0.79	6.0	6.29	4.71	**3.74**	18	71	0.012	0.001081	0.0051	4.6	**8.1**	4.4	0.27	6.56	3.26	2.90	Q ok
P-118	DI-118	DI-113	2866	196	3062	0.07	0.90	0.06	0.86	6.0	6.56	4.65	**3.99**	18	27	0.012	0.001228	0.0048	4.5	**7.9**	4.4	0.10	6.66	2.80	2.67	Q ok
P-113	DI-113	DI-114	2882	195	3077	0.07	0.90	0.06	1.48	6.0	6.66	4.63	**6.86**	18	41	0.012	0.003630	0.0200	9.1	**16.1**	8.8	0.08	6.74	2.57	1.75	Q ok
P-114	DI-114	MH-170	1592	20	1612	0.04	0.94	0.03	1.52	6.0	6.74	4.63	**7.02**	18	47	0.012	0.003803	0.0200	9.1	**16.1**	8.8	0.09	6.83	1.65	0.71	Q ok
P-110	B4 South	MH-111	22751	0	22751	0.52	0.95	0.50	0.50	6.0	0.00	4.77	**2.37**	18	17	0.012	0.000433	0.0053	4.7	**8.3**	4.0	0.07	6.07	3.61	3.52	Q ok
P-111	MH-111	DI-112	1	0	1	0.00	0.95	0.00	0.50	6.0	6.07	4.75	**2.36**	18	60	0.012	0.000429	0.0050	4.6	**8.0**	3.9	0.26	6.33	3.42	3.12	Q ok
P-112	DI-112	DI-113	2877	164	3041	0.07	0.91	0.06	0.56	6.0	6.33	4.71	**2.64**	18	71	0.012	0.000536	0.0049	4.5	**8.0**	4.1	0.29	6.62	3.02	2.67	Q ok
P-120	DI-120	DI-121	2879	334	3213	0.07	0.87	0.06	0.06	6.0	0.00	4.77	**0.31**	15	22	0.012	0.000019	0.0032	3.2	**3.9**	1.9	0.19	6.19	**3.96**	3.89	Q ok
P-121	DI-121	DI-122	5403	1316	6719	0.15	0.80	0.12	0.19	6.0	6.19	4.73	**0.89**	15	84	0.012	0.000161	0.0031	3.2	**3.9**	2.6	0.54	6.73	3.79	3.53	Q ok
P-122	DI-122	MH-123	4404	1304	5708	0.13	0.77	0.10	0.29	6.0	6.73	4.63	**1.34**	15	56	0.012	0.000365	0.0030	3.1	**3.9**	2.8	0.33	7.06	3.43	3.26	Q ok
P-123	MH-123	DI-124	1	0	1	0.00	0.95	0.00	1.01	6.0	7.06	4.55	**4.62**	**24**	36	0.012	0.000355	0.0036	4.7	**14.7**	4.0	0.15	7.21	3.16	3.03	Q ok
P-124	DI-124	MH-135	3437	323	3760	0.09	0.88	0.08	1.13	6.0	7.21	4.53	**5.10**	**24**	31	0.012	0.000433	0.0048	5.4	**17.0**	4.6	0.11	7.32	2.93	2.78	Q ok
P-125	DI-125	DI-124	1587	15	1602	0.04	0.94	0.03	0.03	6.0	0.00	4.77	**0.17**	15	45	0.012	0.000006	0.0040	3.6	**4.4**	1.8	0.42	6.42	3.21	3.03	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 2	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-126	B5 North	MH-123	33276	0	33276	0.76	0.95	0.73	0.73	6.0	0.00	4.77	**3.46**	18	17	0.012	0.000925	0.0053	4.7	**8.3**	4.3	0.07	6.07	3.36	3.27	Q ok
P-130	DI-130	DI-131	2606	339	2945	0.07	0.86	0.06	0.06	6.0	0.00	4.77	**0.28**	15	22	0.012	0.000016	0.0032	3.2	**3.9**	1.6	0.23	6.23	**3.96**	3.89	Q ok
P-131	DI-131	DI-132	5203	1533	6736	0.15	0.77	0.12	0.18	6.0	6.23	4.73	**0.84**	15	83	0.012	0.000145	0.0030	3.1	**3.8**	2.3	0.59	6.82	3.79	3.54	Q ok
P-132	DI-132	MH-133	4517	1246	5763	0.13	0.78	0.10	0.28	6.0	6.82	4.61	**1.30**	15	56	0.012	0.000344	0.0030	3.1	**3.9**	2.8	0.33	7.15	3.44	3.27	Q ok
P-133	MH-133	DI-134	1	0	1	0.00	0.95	0.00	0.82	6.0	7.15	4.53	**3.70**	24	36	0.012	0.000228	0.0031	4.3	**13.5**	3.5	0.17	7.32	3.17	3.06	Q ok
P-134	DI-134	MH-135	4193	284	4477	0.10	0.90	0.09	0.91	6.0	7.32	4.51	**4.10**	**24**	31	0.012	0.000281	0.0035	4.6	**14.6**	3.9	0.13	7.45	2.96	2.85	Q ok
P-135	MH-135	MH-170	1	0	1	0.00	0.95	0.00	2.04	6.0	7.45	4.47	**9.10**	**30**	94	0.012	0.000419	0.0039	5.7	**27.9**	5.1	0.31	7.76	2.67	2.30	Q ok
P-136	B3 South	MH-133	24569	0	24569	0.56	0.95	0.54	0.54	6.0	0.00	4.77	**2.56**	18	17	0.012	0.000504	0.0047	4.4	**7.8**	4.0	0.07	6.07	3.36	3.28	Q ok
P-144	DI-144	MH-145	2618	65	2683	0.06	0.93	0.06	0.06	6.0	0.00	4.77	**0.27**	15	55	0.012	0.000015	0.0051	4.1	**5.0**	2.0	0.46	6.46	3.79	3.51	Q ok
P-145	MH-145	DI-146	1	0	1	0.00	0.95	0.00	0.59	6.0	6.46	4.67	**2.77**	18	39	0.012	0.000593	0.0049	4.5	**7.9**	4.0	0.16	6.62	3.41	3.22	Q ok
P-146	DI-146	DI-147	3675	195	3870	0.09	0.91	0.08	0.67	6.0	6.62	4.65	**3.13**	18	68	0.012	0.000759	0.0050	4.6	**8.0**	4.2	0.27	6.89	3.12	2.78	Q ok
P-147	DI-147	DI-143	5191	266	5457	0.13	0.91	0.11	0.79	6.0	6.89	4.59	**3.62**	18	25	0.012	0.001011	0.0052	4.6	**8.2**	4.5	0.09	6.98	2.68	2.55	Q ok
P-148	B3 West	MH-145	24569	0	24569	0.56	0.95	0.54	0.54	6.0	0.00	4.77	**2.56**	18	17	0.012	0.000504	0.0053	4.7	**8.3**	4.0	0.07	6.07	3.60	3.51	Q ok
P-167	DI-167	DI-159	3909	227	4136	0.09	0.91	0.09	0.09	6.0	6.00	4.01	**0.35**	15	18	0.012	0.000024	0.0033	3.3	**4.0**	2.0	0.15	6.15	4.29	4.23	Q ok
P-159	DI-159	DI-150	3909	227	4136	0.09	0.91	0.09	0.17	6.0	6.15	3.98	**0.69**	15	100	0.012	0.000096	0.0053	4.2	**5.1**	2.9	0.57	6.73	4.13	3.60	Q ok
P-150	DI-150	MH-151	3037	0	3037	0.07	0.95	0.07	0.24	6.0	0.00	4.77	**1.14**	15	24	0.012	0.000265	0.0042	3.7	**4.5**	3.0	0.13	6.13	3.50	3.40	Q ok
P-151	MH-151	DI-152	1	0	1	0.00	0.95	0.00	1.58	6.0	6.13	4.75	**7.52**	24	51	0.012	0.000942	0.0039	4.9	**15.3**	4.8	0.18	6.31	3.30	3.10	Q ok
P-153	B1	MH-151	61668	0	61668	1.42	0.95	1.34	1.34	6.0	0.00	4.77	**6.42**	24	17	0.012	0.000685	0.0100	7.8	**24.5**	6.4	0.04	6.04	3.57	3.40	Q ok
P-157	B3 North	MH-155	24569	0	24569	0.56	0.95	0.54	0.54	6.0	0.00	4.77	**2.56**	18	18	0.012	0.000504	0.0050	4.6	**8.0**	3.9	0.08	6.08	3.72	3.63	Q ok
P-166	B2 North	MH-163	21657	0	21657	0.50	0.95	0.47	0.47	6.0	0.00	4.77	**2.25**	18	50	0.012	0.000392	0.0050	4.6	**8.0**	3.9	0.22	6.22	3.62	3.37	Q ok
P-163	MH-163	MH-140	1	0	1	0.00	0.95	0.00	1.24	6.0	6.22	4.73	**5.88**	18	44	0.012	0.002674	0.0150	7.9	**13.9**	7.3	0.10	6.32	3.27	2.61	Q ok

KEY	
	Upsized from Semi-Final Design to have capacity for 50-yr design storm
	Optional Upsize-50-yr design storm results in >85% Full
	No Change from Semi-Final Design

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	4.91	4.91	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	4.93	7.70	HGL ok
P-154	DI-154	MH-155	1.00	4.91	4.91	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.91	9.06	HGL ok
P-155	MH-155	DI-156	1.20	4.84	4.84	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	4.91	10.06	HGL ok
P-156	DI-156	DI-152	1.20	4.74	4.74	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	4.84	11.07	HGL ok
P-152	DI-152	MH-140	2.00	4.62	4.62	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	4.74	11.07	HGL ok
P-140	MH-140	DI-141	2.40	4.14	4.52	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	4.62	12.04	HGL ok
P-141	DI-141	DI-142	2.40	3.92	4.04	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	4.14	11.02	HGL ok
P-142	DI-142	DI-143	2.40	3.83	3.83	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	3.92	10.52	HGL ok
P-143	DI-143	MH-170	2.40	3.70	3.70	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	3.83	10.28	HGL ok
P-170	MH-170	MH-171	3.20	3.43	3.59	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	3.70	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.37	3.37	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	3.43	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.30	3.30	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	3.37	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.20**	**3.20**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**3.30**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	3.43	3.43	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.43	10.61	HGL ok
P-175	DI-175	MH-171	1.20	3.43	3.43	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.43	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.37	3.37	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	3.39	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.37	3.37	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	3.39	10.00	HGL ok
P-178	TD-03	DI-179	0.53	3.44	6.23	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	6.48	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.30	3.30	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	3.44	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.33	6.78	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	6.83	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.30	3.30	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	3.33	9.25	HGL ok
P-115	B5 West	MH-116	1.20	4.72	4.96	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	4.98	10.00	HGL ok
P-116	MH-116	DI-117	1.20	4.62	4.62	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	4.72	11.99	HGL ok
P-117	DI-117	DI-118	1.20	4.50	4.50	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	4.62	11.71	HGL ok
P-118	DI-118	DI-113	1.20	4.38	4.38	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	4.50	11.30	HGL ok
P-113	DI-113	DI-114	1.20	4.09	4.09	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	4.38	11.30	HGL ok
P-114	DI-114	MH-170	1.20	3.70	3.70	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	4.09	10.75	HGL ok
P-110	B4 South	MH-111	1.20	4.49	4.72	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.73	10.00	HGL ok
P-111	MH-111	DI-112	1.20	4.44	4.44	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	4.49	11.99	HGL ok
P-112	DI-112	DI-113	1.20	4.38	4.38	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	4.44	11.71	HGL ok
P-120	DI-120	DI-121	1.00	4.72	4.89	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-121	DI-121	DI-122	1.00	4.71	4.71	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	4.72	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.68	4.68	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	4.71	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.44	4.63	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	4.68	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.37	4.38	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	4.44	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.44	4.44	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.44	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.68	4.68	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	4.70	10.00	HGL ok
P-130	DI-130	DI-131	1.00	4.73	4.89	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.72	4.72	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	4.73	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.69	4.69	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	4.72	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.49	4.66	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	4.69	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.37	4.45	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	4.49	9.44	HGL ok
P-135	MH-135	MH-170	2.00	3.70	4.30	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	4.37	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.69	4.69	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.70	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	4.46	4.51	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.51	11.02	HGL ok
P-145	MH-145	DI-146	1.20	4.07	4.42	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	4.46	10.87	HGL ok
P-146	DI-146	DI-147	1.20	3.95	3.98	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	4.07	10.52	HGL ok
P-147	DI-147	DI-143	1.20	3.83	3.83	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	3.95	10.28	HGL ok
P-148	B3 West	MH-145	1.20	4.46	4.71	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.72	10.00	HGL ok
P-167	DI-167	DI-159	1.00	4.91	5.23	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.23	7.48	HGL ok
P-159	DI-159	DI-150	1.00	4.85	4.85	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	4.91	7.70	HGL ok
P-150	DI-150	MH-151	1.00	4.84	4.84	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	4.85	9.06	HGL ok
P-151	MH-151	DI-152	1.60	4.74	4.74	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	4.84	10.06	HGL ok
P-153	B1	MH-151	1.60	4.84	5.00	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	5.02	10.00	HGL ok
P-157	B3 North	MH-155	1.20	4.91	4.91	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.92	10.00	HGL ok
P-166	B2 North	MH-163	1.20	4.78	4.78	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	4.81	10.00	HGL ok
P-163	MH-163	MH-140	1.20	4.62	4.62	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	4.78	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location No.	Location From	Location To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
			0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	4.91	4.91	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	4.93	7.70	HGL ok
P-154	DI-154	MH-155	1.00	4.91	4.91	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.91	9.06	HGL ok
P-155	MH-155	DI-156	1.20	4.84	4.84	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	4.91	10.06	HGL ok
P-156	DI-156	DI-152	1.20	4.74	4.74	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	4.84	11.07	HGL ok
P-152	DI-152	MH-140	2.00	4.62	4.62	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	4.74	11.07	HGL ok
P-140	MH-140	DI-141	2.40	4.14	4.52	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	4.62	12.04	HGL ok
P-141	DI-141	DI-142	2.40	3.96	4.04	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	4.14	11.02	HGL ok
P-142	DI-142	DI-143	2.40	3.87	3.87	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	3.96	10.52	HGL ok
P-143	DI-143	MH-170	2.40	3.74	3.74	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	3.87	10.28	HGL ok
P-170	MH-170	MH-171	3.20	3.63	3.63	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	3.74	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.57	3.57	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	3.63	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.50	3.50	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	3.57	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.40**	**3.40**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**3.50**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	3.63	3.63	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.63	10.61	HGL ok
P-175	DI-175	MH-171	1.20	3.63	3.63	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.63	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.57	3.57	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	3.59	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.57	3.57	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	3.59	10.00	HGL ok
P-178	TD-03	DI-179	0.53	3.64	6.23	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	6.48	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.50	3.50	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	3.64	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.53	6.78	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	6.83	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.50	3.50	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	3.53	9.25	HGL ok
P-115	B5 West	MH-116	1.20	4.76	4.96	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	4.98	10.00	HGL ok
P-116	MH-116	DI-117	1.20	4.67	4.67	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	4.76	11.99	HGL ok
P-117	DI-117	DI-118	1.20	4.54	4.54	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	4.67	11.71	HGL ok
P-118	DI-118	DI-113	1.20	4.42	4.42	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	4.54	11.30	HGL ok
P-113	DI-113	DI-114	1.20	4.14	4.14	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	4.42	11.30	HGL ok
P-114	DI-114	MH-170	1.20	3.74	3.74	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	4.14	10.75	HGL ok
P-110	B4 South	MH-111	1.20	4.53	4.72	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.73	10.00	HGL ok
P-111	MH-111	DI-112	1.20	4.48	4.48	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	4.53	11.99	HGL ok
P-112	DI-112	DI-113	1.20	4.42	4.42	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	4.48	11.71	HGL ok
P-120	DI-120	DI-121	1.00	4.72	4.89	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-121	DI-121	DI-122	1.00	4.71	4.71	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	4.72	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.68	4.68	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	4.71	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.44	4.63	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	4.68	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.37	4.38	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	4.44	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.44	4.44	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.44	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.68	4.68	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	4.70	10.00	HGL ok
P-130	DI-130	DI-131	1.00	4.73	4.89	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.72	4.72	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	4.73	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.69	4.69	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	4.72	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.49	4.66	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	4.69	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.37	4.45	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	4.49	9.44	HGL ok
P-135	MH-135	MH-170	2.00	3.74	4.30	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	4.37	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.69	4.69	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.70	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	4.46	4.51	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.51	11.02	HGL ok
P-145	MH-145	DI-146	1.20	4.08	4.42	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	4.46	10.87	HGL ok
P-146	DI-146	DI-147	1.20	3.99	3.99	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	4.08	10.52	HGL ok
P-147	DI-147	DI-143	1.20	3.87	3.87	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	3.99	10.28	HGL ok
P-148	B3 West	MH-145	1.20	4.46	4.71	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.72	10.00	HGL ok
P-167	DI-167	DI-159	1.00	4.91	5.23	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.23	7.48	HGL ok
P-159	DI-159	DI-150	1.00	4.85	4.85	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	4.91	7.70	HGL ok
P-150	DI-150	MH-151	1.00	4.84	4.84	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	4.85	9.06	HGL ok
P-151	MH-151	DI-152	1.60	4.74	4.74	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	4.84	10.06	HGL ok
P-153	B1	MH-151	1.60	4.84	5.00	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	5.02	10.00	HGL ok
P-157	B3 North	MH-155	1.20	4.91	4.91	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	4.92	10.00	HGL ok
P-166	B2 North	MH-163	1.20	4.78	4.78	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	4.81	10.00	HGL ok
P-163	MH-163	MH-140	1.20	4.62	4.62	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	4.78	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 2 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	7.96	7.96	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.97	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	7.95	7.95	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.96	9.06	HGL ok
P-155	MH-155	DI-156	1.20	7.89	7.89	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	7.95	10.06	HGL ok
P-156	DI-156	DI-152	1.20	7.79	7.79	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	7.89	11.07	HGL ok
P-152	DI-152	MH-140	2.00	7.67	7.67	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	7.79	11.07	HGL ok
P-140	MH-140	DI-141	2.40	7.56	7.56	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	7.67	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.46	7.46	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	7.56	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.37	7.37	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	7.46	10.52	HGL ok
P-143	DI-143	MH-170	2.40	7.24	7.24	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	7.37	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.13	7.13	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	7.24	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.07	7.07	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	7.13	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.00	7.00	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	7.07	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**7.00**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.13	7.13	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.13	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.13	7.13	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.13	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.07	7.07	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	7.09	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.07	7.07	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	7.09	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.14	7.14	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	7.39	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.00	7.00	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	7.14	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.03	7.03	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	7.08	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.00	7.00	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	7.03	9.25	HGL ok
P-115	B5 West	MH-116	1.20	8.26	8.26	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	8.28	10.00	HGL ok
P-116	MH-116	DI-117	1.20	8.17	8.17	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	8.26	11.99	HGL ok
P-117	DI-117	DI-118	1.20	8.04	8.04	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	8.17	11.71	HGL ok
P-118	DI-118	DI-113	1.20	7.92	7.92	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	8.04	11.30	HGL ok
P-113	DI-113	DI-114	1.20	7.64	7.64	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	7.92	11.30	HGL ok
P-114	DI-114	MH-170	1.20	7.24	7.24	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	7.64	10.75	HGL ok
P-110	B4 South	MH-111	1.20	8.03	8.03	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.04	10.00	HGL ok
P-111	MH-111	DI-112	1.20	7.98	7.98	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	8.03	11.99	HGL ok
P-112	DI-112	DI-113	1.20	7.92	7.92	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	7.98	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.46	7.46	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.46	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.45	7.45	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	7.46	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.42	7.42	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	7.45	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.37	7.37	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	7.42	8.91	HGL ok
P-124	DI-124	MH-135	1.60	7.31	7.31	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	7.37	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.37	7.37	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.37	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.42	7.42	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	7.44	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.42	7.42	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.42	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.40	7.40	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	7.42	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.38	7.38	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	7.40	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.35	7.35	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	7.38	8.91	HGL ok
P-134	DI-134	MH-135	1.60	7.31	7.31	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	7.35	9.44	HGL ok
P-135	MH-135	MH-170	2.00	7.24	7.24	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	7.31	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.38	7.38	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.39	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	7.62	7.62	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.62	11.02	HGL ok
P-145	MH-145	DI-146	1.20	7.58	7.58	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	7.62	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.49	7.49	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	7.58	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.37	7.37	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	7.49	10.28	HGL ok
P-148	B3 West	MH-145	1.20	7.62	7.62	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.63	10.00	HGL ok
P-167	DI-167	DI-159	1.00	7.95	7.95	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.96	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	7.89	7.89	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	7.95	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	7.88	7.88	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.89	9.06	HGL ok
P-151	MH-151	DI-152	1.60	7.79	7.79	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	7.88	10.06	HGL ok
P-153	B1	MH-151	1.60	7.88	7.88	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	7.90	10.00	HGL ok
P-157	B3 North	MH-155	1.20	7.95	7.95	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.96	10.00	HGL ok
P-166	B2 North	MH-163	1.20	7.83	7.83	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	7.85	10.00	HGL ok
P-163	MH-163	MH-140	1.20	7.67	7.67	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	7.83	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)	

Location: No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
			0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	8.46	8.46	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.47	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	8.45	8.45	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.46	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	8.39	8.39	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	8.45	10.06	HGL ok
P-156	DI-156	DI-152	1.20	8.29	8.29	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	8.39	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.17	8.17	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	8.29	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.06	8.06	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	8.17	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.96	7.96	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	8.06	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.87	7.87	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	7.96	10.52	HGL ok
P-143	DI-143	MH-170	2.40	7.74	7.74	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	7.87	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.63	7.63	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	7.74	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.57	7.57	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	7.63	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.50	7.50	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	7.57	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**7.50**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.63	7.63	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.63	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.63	7.63	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.63	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.57	7.57	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	7.59	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.57	7.57	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	7.59	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.64	7.64	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	7.89	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.50	7.50	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	7.64	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.53	7.53	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	7.58	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.50	7.50	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	7.53	9.25	HGL ok
P-115	B5 West	MH-116	1.20	8.76	8.76	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	8.78	10.00	HGL ok
P-116	MH-116	DI-117	1.20	8.67	8.67	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	8.76	11.99	HGL ok
P-117	DI-117	DI-118	1.20	8.54	8.54	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	8.67	11.71	HGL ok
P-118	DI-118	DI-113	1.20	8.42	8.42	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	8.54	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.14	8.14	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	8.42	11.30	HGL ok
P-114	DI-114	MH-170	1.20	7.74	7.74	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	8.14	10.75	HGL ok
P-110	B4 South	MH-111	1.20	8.53	8.53	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.54	10.00	HGL ok
P-111	MH-111	DI-112	1.20	8.48	8.48	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	8.53	11.99	HGL ok
P-112	DI-112	DI-113	1.20	8.42	8.42	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	8.48	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.96	7.96	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.96	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.95	7.95	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	7.96	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.92	7.92	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	7.95	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.87	7.87	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	7.92	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	7.81	7.81	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	7.87	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.87	7.87	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.87	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.92	7.92	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	7.94	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.92	7.92	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.92	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.90	7.90	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	7.92	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.88	7.88	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	7.90	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.85	7.85	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	7.88	8.91	HGL ok
P-134	DI-134	MH-135	1.60	7.81	7.81	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	7.85	9.44	HGL ok
P-135	MH-135	MH-170	2.00	7.74	7.74	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	7.81	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.88	7.88	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.89	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.12	8.12	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.12	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.08	8.08	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	8.12	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.99	7.99	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	8.08	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.87	7.87	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	7.99	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.12	8.12	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.13	10.00	HGL ok
P-167	DI-167	DI-159	1.00	8.45	8.45	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.46	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	8.39	8.39	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	8.45	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	8.38	8.38	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.39	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.29	8.29	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	8.38	10.06	HGL ok
P-153	B1	MH-151	1.60	8.38	8.38	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	8.40	10.00	HGL ok
P-157	B3 North	MH-155	1.20	8.45	8.45	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.46	10.00	HGL ok
P-166	B2 North	MH-163	1.20	8.33	8.33	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	8.35	10.00	HGL ok
P-163	MH-163	MH-140	1.20	8.17	8.17	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	8.33	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle Δ_o	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Hi= H_Δ +H_t +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	8.86	8.86	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.87	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	8.85	8.85	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.86	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	8.79	8.79	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	8.85	10.06	HGL ok
P-156	DI-156	DI-152	1.20	8.69	8.69	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	8.79	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.57	8.57	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	8.69	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.46	8.46	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	8.57	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.36	8.36	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	8.46	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.27	8.27	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	8.36	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.14	8.14	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	8.27	10.28	HGL ok
P-170	MH-170	MH-171	3.20	8.03	8.03	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	8.14	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.97	7.97	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	8.03	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.90	7.90	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	7.97	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**7.90**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.03	8.03	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.03	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.03	8.03	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.03	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.97	7.97	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	7.99	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.97	7.97	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	7.99	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.04	8.04	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	8.29	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.90	7.90	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	8.04	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.93	7.93	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	7.98	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.90	7.90	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	7.93	9.25	HGL ok
P-115	B5 West	MH-116	1.20	9.16	9.16	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	9.18	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.07	9.07	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	9.16	11.99	HGL ok
P-117	DI-117	DI-118	1.20	8.94	8.94	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	9.07	11.71	HGL ok
P-118	DI-118	DI-113	1.20	8.82	8.82	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	8.94	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.54	8.54	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	8.82	11.30	HGL ok
P-114	DI-114	MH-170	1.20	8.14	8.14	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	8.54	10.75	HGL ok
P-110	B4 South	MH-111	1.20	8.93	8.93	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.94	10.00	HGL ok
P-111	MH-111	DI-112	1.20	8.88	8.88	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	8.93	11.99	HGL ok
P-112	DI-112	DI-113	1.20	8.82	8.82	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	8.88	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.36	8.36	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.36	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.35	8.35	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	8.36	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.32	8.32	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	8.35	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.27	8.27	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	8.32	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.21	8.21	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	8.27	9.44	HGL ok
P-125	DI-125	DI-124	1.00	8.27	8.27	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.27	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.32	8.32	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	8.34	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.32	8.32	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.32	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.30	8.30	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	8.32	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.28	8.28	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	8.30	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.25	8.25	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	8.28	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.21	8.21	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	8.25	9.44	HGL ok
P-135	MH-135	MH-170	2.00	8.14	8.14	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	8.21	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.28	8.28	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.29	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.52	8.52	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.52	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.48	8.48	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	8.52	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.39	8.39	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	8.48	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.27	8.27	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	8.39	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.52	8.52	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.53	10.00	HGL ok
P-167	DI-167	DI-159	1.00	8.85	8.85	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.86	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	8.79	8.79	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	8.85	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	8.78	8.78	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.79	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.69	8.69	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	8.78	10.06	HGL ok
P-153	B1	MH-151	1.60	8.78	8.78	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	8.80	10.00	HGL ok
P-157	B3 North	MH-155	1.20	8.85	8.85	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	8.86	10.00	HGL ok
P-166	B2 North	MH-163	1.20	8.73	8.73	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	8.75	10.00	HGL ok
P-163	MH-163	MH-140	1.20	8.57	8.57	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	8.73	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 2 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	9.36	9.36	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.37	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.35	9.35	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.36	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.29	9.29	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	*0.5*	0.02	0.06	9.35	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	9.19	9.19	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	9.29	11.07	HGL ok
P-152	DI-152	MH-140	2.00	9.07	9.07	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	9.19	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.96	8.96	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	*0.5*	0.05	0.10	9.07	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.86	8.86	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	8.96	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.77	8.77	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	8.86	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.64	8.64	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	*0.5*	0.04	0.13	8.77	10.28	HGL ok
P-170	MH-170	MH-171	3.20	8.53	8.53	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	*0.5*	0.08	0.11	8.64	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.47	8.47	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	*0.5*	0.04	0.06	8.53	10.83	HGL ok
P-172	MH-172	MH-173	3.20	8.40	8.40	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	*0.5*	0.04	0.07	8.47	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	***0.5***	**0.05**	**0.10**	**8.40**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.53	8.53	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.53	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.53	8.53	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.53	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.47	8.47	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.03	8.49	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.47	8.47	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.03	8.49	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.54	8.54	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	8.79	10.50	HGL ok
P-179	DI-179	MH-173	1.00	8.40	8.40	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	*1.3*	1.0	0.13	0.14	8.54	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	8.43	8.43	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	8.48	10.50	HGL ok
P-181	DI-181	MH-173	1.00	8.40	8.40	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	*1.3*	1.0	0.03	0.04	8.43	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	9.66	9.66	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.02	9.68	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.57	9.57	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	*0.5*	0.04	0.09	9.66	11.99	HGL ok
P-117	DI-117	DI-118	1.20	9.44	9.44	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	9.57	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.32	9.32	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	9.44	11.30	HGL ok
P-113	DI-113	DI-114	1.20	9.04	9.04	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	9.32	11.30	HGL ok
P-114	DI-114	MH-170	1.20	8.64	8.64	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	9.04	10.75	HGL ok
P-110	B4 South	MH-111	1.20	9.43	9.43	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	9.44	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.38	9.38	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	*0.5*	0.02	0.04	9.43	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.32	9.32	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	*1.3*	1.0	0.03	0.07	9.38	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.86	8.86	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.86	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.85	8.85	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.02	8.86	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.82	8.82	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.03	8.85	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.77	8.77	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	*0.5*	0.03	0.05	8.82	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.71	8.71	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	8.77	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	8.77	8.77	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.77	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.82	8.82	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	8.84	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.82	8.82	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.82	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.80	8.80	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	8.82	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.78	8.78	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.03	8.80	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.75	8.75	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	*0.5*	0.02	0.03	8.78	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.71	8.71	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	8.75	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.64	8.64	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	*0.5*	0.03	0.07	8.71	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.78	8.78	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	8.79	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.02	9.02	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.02	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.98	8.98	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	9.02	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.89	8.89	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	8.98	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.77	8.77	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	8.89	10.28	HGL ok
P-148	B3 West	MH-145	1.20	9.02	9.02	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	9.03	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	9.35	9.35	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.36	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.29	9.29	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	9.35	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.28	9.28	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.29	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	9.19	9.19	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	9.28	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.28	9.28	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	9.30	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	9.35	9.35	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	9.36	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.23	9.23	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	9.25	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.07	9.07	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	9.23	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	10.06	10.06	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.07	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.05	10.05	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.06	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.99	9.99	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	*0.5*	0.02	0.06	10.05	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	9.89	9.89	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	9.99	11.07	HGL ok
P-152	DI-152	MH-140	2.00	9.77	9.77	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	9.89	11.07	HGL ok
P-140	MH-140	DI-141	2.40	9.66	9.66	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	*0.5*	0.05	0.10	9.77	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.56	9.56	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	9.66	11.02	HGL ok
P-142	DI-142	DI-143	2.40	9.47	9.47	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	9.56	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.34	9.34	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	*0.5*	0.04	0.13	9.47	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.23	9.23	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	*0.5*	0.08	0.11	9.34	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.17	9.17	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	*0.5*	0.04	0.06	9.23	10.83	HGL ok
P-172	MH-172	MH-173	3.20	9.10	9.10	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	*0.5*	0.04	0.07	9.17	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	***0.5***	**0.05**	**0.10**	**9.10**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	9.23	9.23	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.23	10.61	HGL ok
P-175	DI-175	MH-171	1.20	9.23	9.23	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.23	10.63	HGL ok
P-176	B4 North	MH-172	1.20	9.17	9.17	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.03	9.19	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.17	9.17	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.03	9.19	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.24	9.24	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	9.49	10.50	HGL ok
P-179	DI-179	MH-173	1.00	9.10	9.10	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	*1.3*	1.0	0.13	0.14	9.24	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.13	9.13	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	9.18	10.50	HGL ok
P-181	DI-181	MH-173	1.00	9.10	9.10	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	*1.3*	1.0	0.03	0.04	9.13	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	10.36	10.36	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.02	10.38	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.27	10.27	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	*0.5*	0.04	0.09	10.36	11.99	HGL ok
P-117	DI-117	DI-118	1.20	10.14	10.14	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	10.27	11.71	HGL ok
P-118	DI-118	DI-113	1.20	10.02	10.02	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	10.14	11.30	HGL ok
P-113	DI-113	DI-114	1.20	9.74	9.74	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	10.02	11.30	HGL ok
P-114	DI-114	MH-170	1.20	9.34	9.34	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	9.74	10.75	HGL ok
P-110	B4 South	MH-111	1.20	10.13	10.13	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	10.14	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.08	10.08	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	*0.5*	0.02	0.04	10.13	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.02	10.02	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	*1.3*	1.0	0.03	0.07	10.08	11.71	HGL ok
P-120	DI-120	DI-121	1.00	9.56	9.56	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.56	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.55	9.55	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.02	9.56	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.52	9.52	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.03	9.55	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.47	9.47	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	*0.5*	0.03	0.05	9.52	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.41	9.41	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	9.47	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.47	9.47	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.47	10.67	HGL ok
P-126	B5 North	MH-123	1.20	9.52	9.52	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	9.54	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.52	9.52	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.52	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.50	9.50	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	9.52	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.48	9.48	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.03	9.50	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.45	9.45	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	*0.5*	0.02	0.03	9.48	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.41	9.41	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	9.45	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.34	9.34	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	*0.5*	0.03	0.07	9.41	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	9.48	9.48	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	9.49	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.72	9.72	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.72	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.68	9.68	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	9.72	10.87	HGL ok
P-146	DI-146	DI-147	1.20	9.59	9.59	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	9.68	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.47	9.47	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	9.59	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	9.72	9.72	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	9.73	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.05	10.05	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.06	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.99	9.99	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.05	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.98	9.98	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.99	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	9.89	9.89	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	9.98	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.98	9.98	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	10.00	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.05	10.05	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.06	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.93	9.93	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	9.95	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.77	9.77	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	9.93	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 2 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o = Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	10.56	10.56	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.57	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.55	10.55	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.56	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.49	10.49	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	10.55	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.39	10.39	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	10.49	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.27	10.27	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	10.39	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.16	10.16	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	10.27	12.04	HGL ok
P-141	DI-141	DI-142	2.40	10.06	10.06	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	10.16	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	9.97	9.97	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	10.06	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.84	9.84	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	9.97	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.73	9.73	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	9.84	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.67	9.67	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	9.73	10.83	HGL ok
P-172	MH-172	MH-173	3.20	9.60	9.60	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	9.67	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**9.60**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	9.73	9.73	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.73	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	9.73	9.73	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.73	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.67	9.67	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	9.69	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.67	9.67	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	9.69	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.74	9.74	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	9.99	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.60	9.60	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	9.74	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.63	9.63	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	9.68	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.60	9.60	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	9.63	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	10.86	10.86	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	10.88	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.77	10.77	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	10.86	11.99	HGL ok
P-117	DI-117	DI-118	1.20	10.64	10.64	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	10.77	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	10.52	10.52	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	10.64	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.24	10.24	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	10.52	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	9.84	9.84	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	10.24	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	10.63	10.63	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.64	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.58	10.58	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	10.63	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.52	10.52	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	10.58	11.71	HGL ok
P-120	DI-120	DI-121	1.00	10.06	10.06	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.06	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.05	10.05	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	10.06	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.02	10.02	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	10.05	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.97	9.97	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	10.02	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.91	9.91	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	9.97	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.97	9.97	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.97	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.02	10.02	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.04	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.02	10.02	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.02	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.00	10.00	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	10.02	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.98	9.98	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	10.00	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.95	9.95	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	9.98	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.91	9.91	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	9.95	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.84	9.84	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	9.91	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	9.98	9.98	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	9.99	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.22	10.22	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.22	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.18	10.18	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	10.22	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.09	10.09	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	10.18	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.97	9.97	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	10.09	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.22	10.22	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.23	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.55	10.55	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.56	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.49	10.49	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.55	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.48	10.48	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.49	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.39	10.39	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	10.48	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.48	10.48	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	10.50	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.55	10.55	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.56	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.43	10.43	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	10.45	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.27	10.27	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	10.43	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 2 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Cm. No.: 20077

Location No.	Location From	Location To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	11.86	11.86	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.87	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.85	11.85	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.86	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.79	11.79	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	11.85	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.69	11.69	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	11.79	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.57	11.57	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	11.69	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.46	11.46	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	11.57	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.36	11.36	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	11.46	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.27	11.27	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	11.36	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.14	11.14	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	11.27	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.03	11.03	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	11.14	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.97	10.97	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	11.03	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.90	10.90	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	10.97	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**10.90**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.03	11.03	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.03	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.03	11.03	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.03	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.97	10.97	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	10.99	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.97	10.97	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	10.99	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.04	11.04	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	11.29	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.90	10.90	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	11.04	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.93	10.93	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	10.98	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.90	10.90	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	10.93	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.16	12.16	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	12.18	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.07	12.07	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	12.16	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.94	11.94	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	12.07	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.82	11.82	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	11.94	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.54	11.54	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	11.82	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.14	11.14	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	11.54	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.93	11.93	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.94	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.88	11.88	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	11.93	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.82	11.82	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	11.88	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.36	11.36	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.36	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.35	11.35	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	11.36	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.32	11.32	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	11.35	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.27	11.27	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	11.32	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.21	11.21	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	11.27	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.27	11.27	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.27	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.32	11.32	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.34	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.32	11.32	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.32	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.30	11.30	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	11.32	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.28	11.28	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	11.30	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.25	11.25	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	11.28	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.21	11.21	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	11.25	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.14	11.14	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	11.21	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.28	11.28	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.29	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.52	11.52	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.52	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.48	11.48	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	11.52	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.39	11.39	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	11.48	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.27	11.27	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	11.39	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.52	11.52	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.53	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.85	11.85	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.86	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.79	11.79	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.85	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.78	11.78	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.79	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.69	11.69	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	11.78	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.78	11.78	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	11.80	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.85	11.85	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.86	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.73	11.73	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	11.75	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.57	11.57	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	11.73	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\ adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\ adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	6.80	6.80	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.81	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	6.79	6.79	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.80	9.06	HGL ok
P-155	MH-155	DI-156	1.20	6.73	6.73	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	*0.5*	0.02	0.06	6.79	10.06	HGL ok
P-156	DI-156	DI-152	1.20	6.63	6.63	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	6.73	11.07	HGL ok
P-152	DI-152	MH-140	2.00	6.51	6.51	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	6.63	11.07	HGL ok
P-140	MH-140	DI-141	2.40	6.40	6.40	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	*0.5*	0.05	0.10	6.51	12.04	HGL ok
P-141	DI-141	DI-142	2.40	6.30	6.30	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	6.40	11.02	HGL ok
P-142	DI-142	DI-143	2.40	6.21	6.21	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	6.30	10.52	HGL ok
P-143	DI-143	MH-170	2.40	6.08	6.08	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	*0.5*	0.04	0.13	6.21	10.28	HGL ok
P-170	MH-170	MH-171	3.20	5.97	5.97	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	*0.5*	0.08	0.11	6.08	11.16	HGL ok
P-171	MH-171	MH-172	3.20	5.91	5.91	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	*0.5*	0.04	0.06	5.97	10.83	HGL ok
P-172	MH-172	MH-173	3.20	5.84	5.84	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	*0.5*	0.04	0.07	5.91	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	***0.5***	**0.05**	**0.10**	**5.84**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	5.97	5.97	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.97	10.61	HGL ok
P-175	DI-175	MH-171	1.20	5.97	5.97	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.97	10.63	HGL ok
P-176	B4 North	MH-172	1.20	5.91	5.91	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.03	5.93	10.00	HGL ok
P-177	B2 South	MH-172	1.20	5.91	5.91	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.03	5.93	10.00	HGL ok
P-178	TD-03	DI-179	0.53	5.98	6.23	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	6.48	10.50	HGL ok
P-179	DI-179	MH-173	1.00	5.84	5.84	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	*1.3*	1.0	0.13	0.14	5.98	9.25	HGL ok
P-180	TD-02	DI-181	0.53	5.87	6.78	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	6.83	10.50	HGL ok
P-181	DI-181	MH-173	1.00	5.84	5.84	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	*1.3*	1.0	0.03	0.04	5.87	9.25	HGL ok
P-115	B5 West	MH-116	1.20	7.10	7.10	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.02	7.12	10.00	HGL ok
P-116	MH-116	DI-117	1.20	7.01	7.01	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	*0.5*	0.04	0.09	7.10	11.99	HGL ok
P-117	DI-117	DI-118	1.20	6.88	6.88	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	7.01	11.71	HGL ok
P-118	DI-118	DI-113	1.20	6.76	6.76	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	6.88	11.30	HGL ok
P-113	DI-113	DI-114	1.20	6.48	6.48	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	6.76	11.30	HGL ok
P-114	DI-114	MH-170	1.20	6.08	6.08	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	6.48	10.75	HGL ok
P-110	B4 South	MH-111	1.20	6.87	6.87	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	6.88	10.00	HGL ok
P-111	MH-111	DI-112	1.20	6.82	6.82	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	*0.5*	0.02	0.04	6.87	11.99	HGL ok
P-112	DI-112	DI-113	1.20	6.76	6.76	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	*1.3*	1.0	0.03	0.07	6.82	11.71	HGL ok
P-120	DI-120	DI-121	1.00	6.30	6.30	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.30	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	6.29	6.29	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.02	6.30	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	6.26	6.26	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.03	6.29	7.81	HGL ok
P-123	MH-123	DI-124	1.60	6.21	6.21	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	*0.5*	0.03	0.05	6.26	8.91	HGL ok
P-124	DI-124	MH-135	1.60	6.15	6.15	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	6.21	9.44	HGL ok
P-125	DI-125	DI-124	1.00	6.21	6.21	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.21	10.67	HGL ok
P-126	B5 North	MH-123	1.20	6.26	6.26	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	6.28	10.00	HGL ok
P-130	DI-130	DI-131	1.00	6.26	6.26	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.26	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	6.24	6.24	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	6.26	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	6.22	6.22	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.03	6.24	7.81	HGL ok
P-133	MH-133	DI-134	1.60	6.19	6.19	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	*0.5*	0.02	0.03	6.22	8.91	HGL ok
P-134	DI-134	MH-135	1.60	6.15	6.15	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	6.19	9.44	HGL ok
P-135	MH-135	MH-170	2.00	6.08	6.08	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	*0.5*	0.03	0.07	6.15	10.15	HGL ok
P-136	B3 South	MH-133	1.20	6.22	6.22	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	6.23	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	6.46	6.46	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.46	11.02	HGL ok
P-145	MH-145	DI-146	1.20	6.42	6.42	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	6.46	10.87	HGL ok
P-146	DI-146	DI-147	1.20	6.33	6.33	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	6.42	10.52	HGL ok
P-147	DI-147	DI-143	1.20	6.21	6.21	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	6.33	10.28	HGL ok
P-148	B3 West	MH-145	1.20	6.46	6.46	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	6.47	10.00	HGL ok
P-167	DI-167	DI-159	1.00	6.79	6.79	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.80	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	6.73	6.73	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	6.79	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	6.72	6.72	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.73	9.06	HGL ok
P-151	MH-151	DI-152	1.60	6.63	6.63	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	6.72	10.06	HGL ok
P-153	B1	MH-151	1.60	6.72	6.72	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	6.74	10.00	HGL ok
P-157	B3 North	MH-155	1.20	6.79	6.79	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	6.80	10.00	HGL ok
P-166	B2 North	MH-163	1.20	6.67	6.67	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	6.69	10.00	HGL ok
P-163	MH-163	MH-140	1.20	6.51	6.51	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	6.67	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle Δ_o	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V$_o$/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Hi= H$_1$ +H$_2$ +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H$_f$ + H$_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	7.00	7.00	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.01	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	6.99	6.99	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.00	9.06	HGL ok
P-155	MH-155	DI-156	1.20	6.93	6.93	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	6.99	10.06	HGL ok
P-156	DI-156	DI-152	1.20	6.83	6.83	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	6.93	11.07	HGL ok
P-152	DI-152	MH-140	2.00	6.71	6.71	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	6.83	11.07	HGL ok
P-140	MH-140	DI-141	2.40	6.60	6.60	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	6.71	12.04	HGL ok
P-141	DI-141	DI-142	2.40	6.50	6.50	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	6.60	11.02	HGL ok
P-142	DI-142	DI-143	2.40	6.41	6.41	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	6.50	10.52	HGL ok
P-143	DI-143	MH-170	2.40	6.28	6.28	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	6.41	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.17	6.17	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	6.28	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.11	6.11	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	6.17	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.04	6.04	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	6.11	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**6.04**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.17	6.17	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.17	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.17	6.17	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.17	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.11	6.11	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	6.13	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.11	6.11	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	6.13	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.18	6.23	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	6.48	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.04	6.04	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	6.18	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.07	6.78	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	6.83	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.04	6.04	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	6.07	9.25	HGL ok
P-115	B5 West	MH-116	1.20	7.30	7.30	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	7.32	10.00	HGL ok
P-116	MH-116	DI-117	1.20	7.21	7.21	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	7.30	11.99	HGL ok
P-117	DI-117	DI-118	1.20	7.08	7.08	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	7.21	11.71	HGL ok
P-118	DI-118	DI-113	1.20	6.96	6.96	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	7.08	11.30	HGL ok
P-113	DI-113	DI-114	1.20	6.68	6.68	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	6.96	11.30	HGL ok
P-114	DI-114	MH-170	1.20	6.28	6.28	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	6.68	10.75	HGL ok
P-110	B4 South	MH-111	1.20	7.07	7.07	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.08	10.00	HGL ok
P-111	MH-111	DI-112	1.20	7.02	7.02	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	7.07	11.99	HGL ok
P-112	DI-112	DI-113	1.20	6.96	6.96	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	7.02	11.71	HGL ok
P-120	DI-120	DI-121	1.00	6.50	6.50	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.50	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	6.49	6.49	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	6.50	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	6.46	6.46	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	6.49	7.81	HGL ok
P-123	MH-123	DI-124	1.60	6.41	6.41	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	6.46	8.91	HGL ok
P-124	DI-124	MH-135	1.60	6.35	6.35	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	6.41	9.44	HGL ok
P-125	DI-125	DI-124	1.00	6.41	6.41	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.41	10.67	HGL ok
P-126	B5 North	MH-123	1.20	6.46	6.46	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	6.48	10.00	HGL ok
P-130	DI-130	DI-131	1.00	6.46	6.46	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.46	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	6.44	6.44	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	6.46	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	6.42	6.42	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	6.44	7.81	HGL ok
P-133	MH-133	DI-134	1.60	6.39	6.39	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	6.42	8.91	HGL ok
P-134	DI-134	MH-135	1.60	6.35	6.35	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	6.39	9.44	HGL ok
P-135	MH-135	MH-170	2.00	6.28	6.28	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	6.35	10.15	HGL ok
P-136	B3 South	MH-133	1.20	6.42	6.42	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	6.43	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	6.66	6.66	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.66	11.02	HGL ok
P-145	MH-145	DI-146	1.20	6.62	6.62	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	6.66	10.87	HGL ok
P-146	DI-146	DI-147	1.20	6.53	6.53	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	6.62	10.52	HGL ok
P-147	DI-147	DI-143	1.20	6.41	6.41	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	6.53	10.28	HGL ok
P-148	B3 West	MH-145	1.20	6.66	6.66	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	6.67	10.00	HGL ok
P-167	DI-167	DI-159	1.00	6.99	6.99	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.00	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	6.93	6.93	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	6.99	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	6.92	6.92	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.93	9.06	HGL ok
P-151	MH-151	DI-152	1.60	6.83	6.83	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	6.92	10.06	HGL ok
P-153	B1	MH-151	1.60	6.92	6.92	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	6.94	10.00	HGL ok
P-157	B3 North	MH-155	1.20	6.99	6.99	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.00	10.00	HGL ok
P-166	B2 North	MH-163	1.20	6.87	6.87	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	6.89	10.00	HGL ok
P-163	MH-163	MH-140	1.20	6.71	6.71	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	6.87	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 2 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	10.50	10.50	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.51	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.49	10.49	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.50	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.43	10.43	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	10.49	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.33	10.33	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	10.43	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.21	10.21	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	10.33	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.10	10.10	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	10.21	12.04	HGL ok
P-141	DI-141	DI-142	2.40	10.00	10.00	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	10.10	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	9.91	9.91	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	10.00	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.78	9.78	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	9.91	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.67	9.67	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	9.78	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.61	9.61	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	9.67	10.83	HGL ok
P-172	MH-172	MH-173	3.20	9.54	9.54	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	9.61	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**9.54**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	9.67	9.67	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.67	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	9.67	9.67	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.67	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.61	9.61	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	9.63	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.61	9.61	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	9.63	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.68	9.68	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	9.93	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.54	9.54	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	9.68	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.57	9.57	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	9.62	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.54	9.54	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	9.57	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	10.80	10.80	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	10.82	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.71	10.71	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	10.80	11.99	HGL ok
P-117	DI-117	DI-118	1.20	10.58	10.58	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	10.71	11.71	HGL ok
P-118	DI-118	DI-113	1.20	10.46	10.46	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	10.58	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.18	10.18	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	10.46	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	9.78	9.78	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	10.18	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	10.57	10.57	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.58	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.52	10.52	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	10.57	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.46	10.46	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	10.52	11.71	HGL ok
P-120	DI-120	DI-121	1.00	10.00	10.00	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.00	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.99	9.99	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	10.00	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.96	9.96	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	9.99	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.91	9.91	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	9.96	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.85	9.85	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	9.91	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.91	9.91	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.91	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	9.96	9.96	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	9.98	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.96	9.96	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.96	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.94	9.94	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	9.96	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.92	9.92	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	9.94	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.89	9.89	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	9.92	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.85	9.85	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	9.89	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.78	9.78	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	9.85	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	9.92	9.92	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	9.93	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.16	10.16	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.16	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.12	10.12	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	10.16	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.03	10.03	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	10.12	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.91	9.91	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	10.03	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.16	10.16	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.17	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.49	10.49	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.50	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.43	10.43	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.49	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.42	10.42	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.43	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.33	10.33	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	10.42	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.42	10.42	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	10.44	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.49	10.49	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.50	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.37	10.37	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	10.39	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.21	10.21	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	10.37	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)	

Location No.	Location From	Location To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D)	Tailwater, link to Inlet WSE of downstream pipe (TW)	Outlet W. S. Elevation (HGL Dn)	Outflow Pipe Diameter (D_o)	Outflow Pipe Design Flow (Q_o)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o)	Skew angle vs. (Δ_o)	Outflow Pipe Length (L)	Friction Slope (S_{fo})	Friction Loss (H_f)	Angle of Curvat (O)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c)	Contraction Loss (H_o)	Q*V for determining controlling inflow pipe (Q1V1)	Q*V for determining controlling inflow pipe (Q2V2)	Q*V for determining controlling inflow pipe (Q3V3)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi)	Controlling In-flow skew (Δ_i)	Bend Loss (H_Δ)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H)	Inlet W. S. Elevation (HGL Up)	Top of Grate (T/G)	HGL Check
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	11.00	11.00	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.01	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.99	10.99	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.00	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.93	10.93	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	10.99	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.83	10.83	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	10.93	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.71	10.71	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	10.83	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.60	10.60	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	10.71	12.04	HGL ok
P-141	DI-141	DI-142	2.40	10.50	10.50	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	10.60	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.41	10.41	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	10.50	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.28	10.28	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	10.41	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.17	10.17	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	10.28	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.11	10.11	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	10.17	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.04	10.04	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	10.11	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**10.04**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.17	10.17	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.17	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.17	10.17	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.17	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.11	10.11	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	10.13	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.11	10.11	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	10.13	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.18	10.18	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	10.43	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.04	10.04	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	10.18	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.07	10.07	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	10.12	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.04	10.04	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	10.07	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	11.30	11.30	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	11.32	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.21	11.21	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	11.30	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.08	11.08	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	11.21	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	10.96	10.96	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	11.08	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.68	10.68	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	10.96	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.28	10.28	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	10.68	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.07	11.07	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.08	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.02	11.02	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	11.07	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	10.96	10.96	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	11.02	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.50	10.50	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.50	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.49	10.49	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	10.50	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.46	10.46	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	10.49	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.41	10.41	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	10.46	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.35	10.35	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	10.41	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.41	10.41	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.41	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.46	10.46	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.48	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.46	10.46	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.46	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.44	10.44	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	10.46	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.42	10.42	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	10.44	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.39	10.39	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	10.42	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.35	10.35	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	10.39	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.28	10.28	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	10.35	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.42	10.42	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.43	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.66	10.66	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.66	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.62	10.62	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	10.66	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.53	10.53	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	10.62	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.41	10.41	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	10.53	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.66	10.66	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.67	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.99	10.99	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.00	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.93	10.93	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.99	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.92	10.92	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.93	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.83	10.83	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	10.92	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.92	10.92	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	10.94	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.99	10.99	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.00	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.87	10.87	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	10.89	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.71	10.71	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	10.87	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	11.40	11.40	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.41	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.39	11.39	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.40	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.33	11.33	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	*0.5*	0.02	0.06	11.39	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.23	11.23	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	11.33	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.11	11.11	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	11.23	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.00	11.00	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	*0.5*	0.05	0.10	11.11	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	10.90	10.90	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	11.00	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.81	10.81	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	10.90	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.68	10.68	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	*0.5*	0.04	0.13	10.81	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.57	10.57	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	*0.5*	0.08	0.11	10.68	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.51	10.51	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	*0.5*	0.04	0.06	10.57	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.44	10.44	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	*0.5*	0.04	0.07	10.51	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	***0.5***	**0.05**	**0.10**	**10.44**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.57	10.57	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.57	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.57	10.57	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.57	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.51	10.51	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.03	10.53	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.51	10.51	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.03	10.53	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.58	10.58	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	10.83	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.44	10.44	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	*1.3*	1.0	0.13	0.14	10.58	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.47	10.47	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	10.52	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.44	10.44	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	*1.3*	1.0	0.03	0.04	10.47	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	11.70	11.70	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.02	11.72	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.61	11.61	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	*0.5*	0.04	0.09	11.70	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.48	11.48	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	11.61	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.36	11.36	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	11.48	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.08	11.08	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	11.36	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.68	10.68	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	11.08	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.47	11.47	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	11.48	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.42	11.42	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	*0.5*	0.02	0.04	11.47	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.36	11.36	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	*1.3*	1.0	0.03	0.07	11.42	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.90	10.90	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.90	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.89	10.89	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.02	10.90	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.86	10.86	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.03	10.89	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.81	10.81	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	*0.5*	0.03	0.05	10.86	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.75	10.75	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	10.81	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.81	10.81	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.81	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.86	10.86	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	10.88	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.86	10.86	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.86	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.84	10.84	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	10.86	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.82	10.82	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.03	10.84	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.79	10.79	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	*0.5*	0.02	0.03	10.82	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.75	10.75	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	10.79	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.68	10.68	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	*0.5*	0.03	0.07	10.75	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.82	10.82	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	10.83	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.06	11.06	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.06	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.02	11.02	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	11.06	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.93	10.93	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	11.02	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.81	10.81	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	10.93	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.06	11.06	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.07	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.39	11.39	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.40	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.33	11.33	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.39	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.32	11.32	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.33	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.23	11.23	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	11.32	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.32	11.32	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	11.34	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.39	11.39	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.40	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.27	11.27	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	11.29	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.11	11.11	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	11.27	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle Δ_o	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_i + H_i + H_i$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	11.90	11.90	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.91	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.89	11.89	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.90	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.83	11.83	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	11.89	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.73	11.73	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	11.83	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.61	11.61	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	11.73	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.50	11.50	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	11.61	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.40	11.40	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	11.50	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.31	11.31	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	11.40	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.18	11.18	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	11.31	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.07	11.07	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	11.18	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.01	11.01	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	11.07	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.94	10.94	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	11.01	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**10.94**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.07	11.07	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.07	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.07	11.07	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.07	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.01	11.01	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	11.03	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.01	11.01	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	11.03	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.08	11.08	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	11.33	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.94	10.94	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	11.08	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.97	10.97	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	11.02	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.94	10.94	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	10.97	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.20	12.20	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	12.22	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.11	12.11	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	12.20	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.98	11.98	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	12.11	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.86	11.86	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	11.98	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.58	11.58	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	11.86	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.18	11.18	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	11.58	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.97	11.97	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.98	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.92	11.92	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	11.97	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.86	11.86	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	11.92	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.40	11.40	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.40	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.39	11.39	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	11.40	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.36	11.36	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	11.39	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.31	11.31	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	11.36	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.25	11.25	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	11.31	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.31	11.31	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.31	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.36	11.36	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.38	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.36	11.36	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.36	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.34	11.34	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	11.36	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.32	11.32	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	11.34	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.29	11.29	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	11.32	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.25	11.25	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	11.29	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.18	11.18	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	11.25	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.32	11.32	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.33	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.56	11.56	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.56	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.52	11.52	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	11.56	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.43	11.43	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	11.52	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.31	11.31	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	11.43	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.56	11.56	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.57	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.89	11.89	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.90	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.83	11.83	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.89	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.82	11.82	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.83	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.73	11.73	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	11.82	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.82	11.82	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	11.84	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.89	11.89	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.90	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.77	11.77	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	11.79	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.61	11.61	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	11.77	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle Δ_o	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_i + H_i + H_i$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.60	12.60	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.61	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.59	12.59	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.60	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.53	12.53	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	12.59	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.43	12.43	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	12.53	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.31	12.31	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	12.43	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.20	12.20	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	12.31	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.10	12.10	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	12.20	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.01	12.01	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	12.10	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.88	11.88	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	12.01	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.77	11.77	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	11.88	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.71	11.71	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	11.77	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.64	11.64	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	11.71	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**11.64**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.77	11.77	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.77	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.77	11.77	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.77	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.71	11.71	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	11.73	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.71	11.71	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	11.73	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.78	11.78	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	12.03	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.64	11.64	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	11.78	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.67	11.67	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	11.72	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.64	11.64	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	11.67	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.90	12.90	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	12.92	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.81	12.81	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	12.90	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.68	12.68	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	12.81	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.56	12.56	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	12.68	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.28	12.28	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	12.56	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.88	11.88	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	12.28	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.67	12.67	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	12.68	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.62	12.62	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	12.67	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.56	12.56	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	12.62	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.10	12.10	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.10	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.09	12.09	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	12.10	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.06	12.06	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	12.09	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.01	12.01	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	12.06	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.95	11.95	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	12.01	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.01	12.01	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.01	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.06	12.06	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.08	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.06	12.06	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.06	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.04	12.04	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	12.06	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.02	12.02	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	12.04	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.99	11.99	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	12.02	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.95	11.95	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	11.99	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.88	11.88	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	11.95	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.02	12.02	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	12.03	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.26	12.26	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.26	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.22	12.22	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	12.26	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.13	12.13	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	12.22	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.01	12.01	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	12.13	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.26	12.26	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	12.27	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.59	12.59	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.60	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.53	12.53	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.59	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.52	12.52	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.53	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.43	12.43	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	12.52	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.52	12.52	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	12.54	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.59	12.59	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	12.60	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.47	12.47	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	12.49	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.31	12.31	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	12.47	10.50	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3	of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077	
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)				

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	13.10	13.10	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.11	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.09	13.09	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.10	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.03	13.03	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	0.5	0.02	0.06	13.09	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.93	12.93	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	13.03	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.81	12.81	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	12.93	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.70	12.70	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	0.5	0.05	0.10	12.81	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.60	12.60	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	12.70	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.51	12.51	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	12.60	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.38	12.38	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	0.5	0.04	0.13	12.51	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.27	12.27	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	0.5	0.08	0.11	12.38	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	12.21	12.21	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	0.5	0.04	0.06	12.27	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	12.14	12.14	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	0.5	0.04	0.07	12.21	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	**0.5**	**0.05**	**0.10**	**12.14**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.27	12.27	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.27	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.27	12.27	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.27	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	12.21	12.21	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	12.23	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	12.21	12.21	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	12.23	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.28	12.28	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	12.53	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	12.14	12.14	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	1.3	1.0	0.13	0.14	12.28	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	12.17	12.17	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	12.22	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	12.14	12.14	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	1.3	1.0	0.03	0.04	12.17	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.40	13.40	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	13.42	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.31	13.31	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.09	13.40	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.18	13.18	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	13.31	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.06	13.06	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	13.18	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.78	12.78	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	13.06	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.38	12.38	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	12.78	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.17	13.17	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	13.18	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.12	13.12	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	0.5	0.02	0.04	13.17	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.06	13.06	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	1.3	1.0	0.03	0.07	13.12	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.60	12.60	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.60	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.59	12.59	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	1.3	1.0	0.00	0.02	12.60	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.56	12.56	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	1.3	1.0	0.01	0.03	12.59	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.51	12.51	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	0.5	0.03	0.05	12.56	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.45	12.45	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	12.51	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.51	12.51	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.51	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.56	12.56	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.58	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.56	12.56	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.56	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.54	12.54	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	1.3	1.0	0.00	0.01	12.56	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.52	12.52	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	1.3	1.0	0.01	0.03	12.54	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.49	12.49	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	0.5	0.02	0.03	12.52	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.45	12.45	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	12.49	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.38	12.38	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	0.5	0.03	0.07	12.45	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.52	12.52	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	12.53	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.76	12.76	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.76	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.72	12.72	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	12.76	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.63	12.63	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	12.72	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.51	12.51	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	12.63	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.76	12.76	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	12.77	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.09	13.09	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.10	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.03	13.03	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.09	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.02	13.02	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.03	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.93	12.93	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	13.02	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.02	13.02	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	13.04	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.09	13.09	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	13.10	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.97	12.97	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	12.99	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.81	12.81	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	12.97	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	14.40	14.40	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.41	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	14.39	14.39	15	0.7	0.6	10	24	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.40	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	14.33	14.33	18	3.2	1.8	89	51	0.0008	0.04	0	0.00	0.01	0.5	3.7	0.0	1.4	0.0	89	0.02	0.05	1.0	*0.5*	0.02	0.06	14.39	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	14.23	14.23	18	3.5	2.0	94	33	0.0009	0.03	0	0.00	0.01	5.9	0.0	0.0	1.8	0.0	89	0.04	0.07	1.0	1.0	0.07	0.10	14.33	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	14.11	14.11	30	11.1	2.3	85	97	0.0006	0.06	0	0.00	0.02	6.8	18.4	0.0	2.4	0.0	3	0.01	0.06	1.0	1.0	0.06	0.12	14.23	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	14.00	14.00	36	16.5	2.3	2	97	0.0005	0.05	0	0.00	0.02	25.0	19.6	0.0	2.3	0.0	85	0.05	0.10	1.0	*0.5*	0.05	0.10	14.11	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	13.90	13.90	36	16.6	2.3	1	96	0.0005	0.05	0	0.00	0.02	38.6	0.0	0.0	2.3	0.0	2	0.00	0.05	1.0	1.0	0.05	0.10	14.00	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	13.81	13.81	36	16.8	2.4	5	68	0.0005	0.04	0	0.00	0.02	39.0	0.0	0.0	2.3	0.0	1	0.00	0.05	1.0	1.0	0.05	0.09	13.90	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	13.68	13.68	36	20.6	2.9	86	115	0.0008	0.09	0	0.00	0.03	40.0	7.4	0.0	2.4	0.0	5	0.01	0.07	1.0	*0.5*	0.04	0.13	13.81	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	13.57	13.57	48	35.6	2.8	0	55	0.0005	0.03	0	0.00	0.03	60.1	27.9	16.9	2.9	0.0	86	0.09	0.17	1.0	*0.5*	0.08	0.11	13.68	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	13.51	13.51	48	36.0	2.9	0	50	0.0005	0.03	0	0.00	0.03	100.6	0.1	0.1	2.8	0.0	0	0.00	0.08	1.0	*0.5*	0.04	0.06	13.57	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	13.44	13.44	48	39.9	3.2	0	44	0.0007	0.03	0	0.00	0.04	102.9	3.2	2.9	2.9	0.0	0	0.00	0.08	1.0	*0.5*	0.04	0.07	13.51	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**42.1**	**3.4**	**0**	**64**	**0.0007**	**0.05**	**0**	**0.00**	**0.04**	**126.7**	**2.1**	**1.0**	**3.2**	**0.1**	**0**	**0.00**	**0.10**	**1.0**	***0.5***	**0.05**	**0.10**	**13.44**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	13.57	13.57	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.57	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	13.57	13.57	18	0.4	0.2	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.57	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	13.51	13.51	18	2.4	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.03	13.53	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	13.51	13.51	18	2.3	1.3	90	55	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.03	13.53	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	13.58	13.58	8	0.9	2.6	56	56	0.0040	0.22	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.25	13.83	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	13.44	13.44	15	1.6	1.3	90	30	0.0005	0.02	0	0.00	0.01	2.3	0.0	0.0	2.6	0.0	56	0.06	0.10	*1.3*	1.0	0.13	0.14	13.58	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	13.47	13.47	8	0.4	1.2	45	45	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	13.52	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	13.44	13.44	15	1.1	0.9	90	30	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	1.2	0.0	45	0.01	0.02	*1.3*	1.0	0.03	0.04	13.47	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.70	14.70	18	3.5	2.0	86	17	0.0009	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.02	14.72	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.61	14.61	18	3.5	2.0	4	60	0.0009	0.06	0	0.00	0.01	6.9	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	*0.5*	0.04	0.09	14.70	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.48	14.48	18	3.7	2.1	89	71	0.0011	0.08	0	0.00	0.02	6.8	0.0	0.0	2.0	0.0	4	0.01	0.04	1.0	1.0	0.04	0.12	14.61	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	14.36	14.36	18	4.0	2.3	72	27	0.0012	0.03	0	0.00	0.02	7.9	0.0	0.0	2.1	0.0	89	0.05	0.09	1.0	1.0	0.09	0.13	14.48	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	14.08	14.08	18	6.9	3.9	25	41	0.0036	0.15	0	0.00	0.06	9.0	3.9	0.0	2.3	0.0	72	0.05	0.13	1.0	1.0	0.13	0.28	14.36	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	13.68	13.68	18	7.0	4.0	97	47	0.0038	0.18	0	0.00	0.06	26.6	0.0	0.0	3.9	0.1	25	0.07	0.21	1.0	1.0	0.21	0.39	14.08	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.47	14.47	18	2.4	1.3	86	17	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	14.48	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.42	14.42	18	2.4	1.3	4	60	0.0004	0.03	0	0.00	0.01	3.2	0.0	0.0	1.3	0.0	86	0.02	0.04	1.0	*0.5*	0.02	0.04	14.47	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	14.36	14.36	18	2.6	1.5	19	71	0.0005	0.04	0	0.00	0.01	3.1	0.0	0.0	1.3	0.0	4	0.00	0.02	*1.3*	1.0	0.03	0.07	14.42	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	13.90	13.90	15	0.3	0.2	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.90	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	13.89	13.89	15	0.9	0.7	7	84	0.0002	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	2	0.00	0.00	*1.3*	1.0	0.00	0.02	13.90	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	13.86	13.86	15	1.3	1.1	14	56	0.0004	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	7	0.00	0.01	*1.3*	1.0	0.01	0.03	13.89	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	13.81	13.81	24	4.6	1.5	81	36	0.0004	0.01	0	0.00	0.01	1.5	6.8	0.0	2.0	0.0	81	0.04	0.07	1.0	*0.5*	0.03	0.05	13.86	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	13.75	13.75	24	5.1	1.6	90	31	0.0004	0.01	0	0.00	0.01	6.8	0.0	0.0	1.5	0.0	81	0.02	0.04	1.0	1.0	0.04	0.06	13.81	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	13.81	13.81	15	0.2	0.1	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.81	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	13.86	13.86	18	3.5	2.0	81	17	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	13.88	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	13.86	13.86	15	0.3	0.2	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.86	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	13.84	13.84	15	0.8	0.7	5	83	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.01	13.86	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	13.82	13.82	15	1.3	1.1	14	56	0.0003	0.02	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	5	0.00	0.01	*1.3*	1.0	0.01	0.03	13.84	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	13.79	13.79	24	3.7	1.2	81	36	0.0002	0.01	0	0.00	0.01	1.4	3.7	0.0	1.4	0.0	81	0.02	0.04	1.0	*0.5*	0.02	0.03	13.82	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	13.75	13.75	24	4.1	1.3	90	31	0.0003	0.01	0	0.00	0.01	4.4	0.0	0.0	1.2	0.0	81	0.01	0.03	1.0	1.0	0.03	0.04	13.79	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	13.68	13.68	30	9.1	1.9	0	94	0.0004	0.04	0	0.00	0.01	5.4	8.3	0.0	1.6	0.0	90	0.03	0.06	1.0	*0.5*	0.03	0.07	13.75	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	13.82	13.82	18	2.6	1.4	81	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.00	0.01	13.83	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	14.06	14.06	15	0.3	0.2	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.06	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	14.02	14.02	18	2.8	1.6	7	39	0.0006	0.02	0	0.00	0.01	0.1	3.7	0.0	1.4	0.0	83	0.02	0.04	1.0	0.5	0.02	0.04	14.06	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	13.93	13.93	18	3.1	1.8	89	68	0.0008	0.05	0	0.00	0.01	4.3	0.0	0.0	1.6	0.0	7	0.00	0.03	1.3	1.0	0.04	0.09	14.02	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	13.81	13.81	18	3.6	2.0	86	25	0.0010	0.03	0	0.00	0.02	5.6	0.0	0.0	1.8	0.0	89	0.03	0.07	1.3	1.0	0.09	0.11	13.93	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	14.06	14.06	18	2.6	1.4	83	17	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	14.07	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	14.39	14.39	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.40	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	14.33	14.33	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	14.39	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	14.32	14.32	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.33	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	14.23	14.23	24	7.6	2.4	3	51	0.0010	0.05	0	0.00	0.02	1.2	13.1	0.0	2.0	0.0	89	0.05	0.09	1.0	0.5	0.05	0.09	14.32	10.06	HGL Too High!
P-153	B1	MH-151	1.60	14.32	14.32	24	6.4	2.0	89	17	0.0007	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	14.34	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	14.39	14.39	18	2.6	1.4	89	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	14.40	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	14.27	14.27	18	2.3	1.3	90	50	0.0004	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	14.29	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	14.11	14.11	18	5.9	3.3	92	44	0.0027	0.12	0	0.00	0.04	2.9	0.0	2.9	1.3	0.0	90	0.02	0.07	1.3	0.5	0.05	0.16	14.27	10.50	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 10	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-158	DI-158	DI-154	3887	225	4112	0.09	0.91	0.09	0.09	6.0	0.00	4.01	**0.34**	15	100	0.012	0.000024	0.0053	4.2	**5.1**	2.0	0.82	6.82	**4.36**	3.83	Q ok
P-154	DI-154	MH-155	3023	31	3054	0.07	0.94	0.07	0.15	6.0	6.82	5.96	**0.90**	15	24	0.012	0.000167	0.0042	3.7	**4.5**	2.8	0.14	6.96	**3.73**	3.63	Q ok
P-155	MH-155	DI-156	1	0	1	0.00	0.95	0.00	0.69	6.0	6.96	5.90	**4.06**	18	51	0.012	0.001273	0.0039	4.0	**7.1**	4.1	0.21	7.17	3.53	3.33	Q ok
P-156	DI-156	DI-152	2725	0	2725	0.06	0.95	0.06	0.75	6.0	7.17	5.85	**4.37**	18	33	0.012	0.001476	0.0039	4.0	**7.1**	4.2	0.13	7.30	3.23	3.10	Q ok
P-152	DI-152	MH-140	3517	0	3517	0.08	0.95	0.08	2.41	6.0	7.30	5.83	**14.03**	**30**	97	0.012	0.000996	0.0040	5.7	**28.2**	5.7	0.28	7.58	3.00	2.61	Q ok
P-140	MH-140	DI-141	1	0	1	0.00	0.95	0.00	3.65	6.0	7.58	5.75	**20.99**	36	97	0.012	0.000844	0.0040	6.5	**45.8**	6.3	0.26	7.84	2.51	2.12	Q ok
P-141	DI-141	DI-142	3263	65	3328	0.08	0.93	0.07	3.72	6.0	7.84	5.70	**21.21**	36	96	0.012	0.000862	0.0040	6.4	**45.5**	6.2	0.26	8.10	2.02	1.64	Q ok
P-142	DI-142	DI-143	3699	195	3894	0.09	0.91	0.08	3.80	6.0	8.10	5.62	**21.38**	36	68	0.012	0.000876	0.0040	6.4	**45.5**	6.2	0.18	8.28	1.54	1.27	Q ok
P-143	DI-143	MH-170	5428	266	5694	0.13	0.91	0.12	4.71	6.0	8.28	5.57	**26.24**	36	115	0.012	0.001319	0.0040	6.5	**45.7**	6.6	0.29	8.57	1.17	0.71	Q ok
P-170	MH-170	MH-171	1	0	1	0.00	0.95	0.00	8.26	6.0	8.57	5.49	**45.38**	48	55	0.012	0.000850	0.0040	7.8	**98.4**	7.6	0.12	8.69	0.61	0.39	Q ok
P-171	MH-171	MH-172	1	0	1	0.00	0.95	0.00	8.44	6.0	8.69	5.47	**46.11**	48	50	0.012	0.000878	0.0040	7.8	**98.4**	7.6	0.11	8.80	0.29	0.09	Q ok
P-172	MH-172	MH-173	1	0	1	0.00	0.95	0.00	9.41	6.0	8.80	5.44	**51.18**	48	44	0.012	0.001082	0.0041	7.9	**99.5**	7.8	0.09	8.89	-0.01	-0.19	Q ok
P-173	MH-173	OUTFALL	1	0	1	0.00	0.95	0.00	9.98	6.0	8.89	5.41	**54.06**	**48**	64	0.012	0.001207	0.0041	7.9	**99.2**	8.1	0.13	9.03	-0.29	**-0.55**	Q ok
P-174	DI-174	MH-171	3578	530	4108	0.09	0.85	0.08	0.08	6.0	0.00	6.16	**0.49**	18	33	0.012	0.000019	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-175	DI-175	MH-171	4118	530	4648	0.11	0.86	0.09	0.09	6.0	0.00	6.16	**0.57**	18	33	0.012	0.000025	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-176	B4 North	MH-172	22780	0	22780	0.52	0.95	0.50	0.50	6.0	0.00	6.16	**3.06**	18	55	0.012	0.000724	0.0049	4.5	**8.0**	4.2	0.22	6.22	1.26	0.99	Q ok
P-177	B2 South	MH-172	21809	0	21809	0.50	0.95	0.48	0.48	6.0	0.00	6.16	**2.93**	18	55	0.012	0.000663	0.0049	4.5	**8.0**	4.1	0.23	6.23	1.26	0.99	Q ok
P-178	TD-03	DI-179	8687	0	8687	0.20	0.95	0.19	0.19	6.0	0.00	6.16	**1.17**	8	56	0.011	0.006682	0.0509	9.2	**3.2**	8.3	0.11	6.11	8.55	5.70	Q ok
P-179	DI-179	MH-173	6306	3055	9361	0.21	0.70	0.15	0.34	6.0	6.11	6.14	**2.08**	15	30	0.012	0.000887	0.0500	12.8	**15.6**	8.9	0.06	6.17	3.21	1.71	Q ok
P-180	TD-02	DI-181	4084	0	4084	0.09	0.95	0.09	0.09	6.0	0.00	6.16	**0.55**	8	45	0.011	0.001477	0.0500	9.1	**3.2**	6.4	0.12	6.12	8.50	6.25	Q ok
P-181	DI-181	MH-173	6222	2906	9128	0.21	0.70	0.15	0.24	6.0	6.12	6.14	**1.45**	15	30	0.012	0.000431	0.0500	12.8	**15.6**	7.7	0.07	6.18	3.21	1.71	Q ok
P-115	B5 West	MH-116	33468	0	33468	0.77	0.95	0.73	0.73	6.0	0.00	6.16	**4.50**	18	17	0.012	0.001562	0.0047	4.4	**7.8**	4.6	0.06	6.06	3.84	3.76	Q ok
P-116	MH-116	DI-117	1	0	1	0.00	0.95	0.00	0.73	6.0	6.06	6.14	**4.48**	18	60	0.012	0.001549	0.0050	4.6	**8.0**	4.6	0.22	6.28	3.66	3.36	Q ok
P-117	DI-117	DI-118	2919	167	3086	0.07	0.91	0.06	0.79	6.0	6.28	6.08	**4.83**	18	71	0.012	0.001804	0.0051	4.6	**8.1**	4.8	0.25	6.52	3.26	2.90	Q ok
P-118	DI-118	DI-113	2866	196	3062	0.07	0.90	0.06	0.86	6.0	6.52	6.03	**5.17**	18	27	0.012	0.002067	0.0048	4.5	**7.9**	4.8	0.09	6.62	2.80	2.67	Q ok
P-113	DI-113	DI-114	2882	195	3077	0.07	0.90	0.06	1.48	6.0	6.62	6.01	**8.90**	18	41	0.012	0.006111	0.0200	9.1	**16.1**	9.3	0.07	6.69	2.57	1.75	Q ok
P-114	DI-114	MH-170	1592	20	1612	0.04	0.94	0.03	1.52	6.0	6.69	5.98	**9.07**	18	47	0.012	0.006347	0.0200	9.1	**16.1**	9.3	0.08	6.77	1.65	0.71	Q ok
P-110	B4 South	MH-111	22751	0	22751	0.52	0.95	0.50	0.50	6.0	0.00	6.16	**3.06**	18	17	0.012	0.000722	0.0053	4.7	**8.3**	4.2	0.07	6.07	3.61	3.52	Q ok
P-111	MH-111	DI-112	1	0	1	0.00	0.95	0.00	0.50	6.0	6.07	6.14	**3.04**	18	60	0.012	0.000716	0.0050	4.6	**8.0**	4.2	0.24	6.31	3.42	3.12	Q ok
P-112	DI-112	DI-113	2877	164	3041	0.07	0.91	0.06	0.56	6.0	6.31	6.08	**3.41**	18	71	0.012	0.000895	0.0049	4.5	**8.0**	4.4	0.27	6.58	3.02	2.67	Q ok
P-120	DI-120	DI-121	2879	334	3213	0.07	0.87	0.06	0.06	6.0	0.00	6.16	**0.40**	15	22	0.012	0.000032	0.0032	3.2	**3.9**	1.9	0.19	6.19	**3.96**	3.89	Q ok
P-121	DI-121	DI-122	5403	1316	6719	0.15	0.80	0.12	0.19	6.0	6.19	6.11	**1.15**	15	84	0.012	0.000268	0.0031	3.2	**3.9**	2.7	0.52	6.71	3.79	3.53	Q ok
P-122	DI-122	MH-123	4404	1304	5708	0.13	0.77	0.10	0.29	6.0	6.71	5.98	**1.73**	15	56	0.012	0.000610	0.0030	3.1	**3.9**	3.0	0.31	7.02	3.43	3.26	Q ok
P-123	MH-123	DI-124	1	0	1	0.00	0.95	0.00	1.01	6.0	7.02	5.90	**5.99**	**24**	36	0.012	0.000597	0.0036	4.7	**14.7**	4.3	0.14	7.15	3.16	3.03	Q ok
P-124	DI-124	MH-135	3437	323	3760	0.09	0.88	0.08	1.13	6.0	7.15	5.85	**6.59**	**24**	31	0.012	0.000722	0.0048	5.4	**17.0**	5.0	0.10	7.26	2.93	2.78	Q ok
P-125	DI-125	DI-124	1587	15	1602	0.04	0.94	0.03	0.03	6.0	0.00	6.16	**0.21**	15	45	0.012	0.000009	0.0040	3.6	**4.4**	1.8	0.42	6.42	3.21	3.03	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 10	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-126	B5 North	MH-123	33276	0	33276	0.76	0.95	0.73	0.73	6.0	0.00	6.16	**4.47**	18	17	0.012	0.001544	0.0053	4.7	**8.3**	4.8	0.06	6.06	3.36	3.27	Q ok
P-130	DI-130	DI-131	2606	339	2945	0.07	0.86	0.06	0.06	6.0	0.00	6.16	**0.36**	15	22	0.012	0.000026	0.0032	3.2	**3.9**	1.9	0.19	6.19	**3.96**	3.89	Q ok
P-131	DI-131	DI-132	5203	1533	6736	0.15	0.77	0.12	0.18	6.0	6.19	6.11	**1.09**	15	83	0.012	0.000242	0.0030	3.1	**3.8**	2.7	0.52	6.71	3.79	3.54	Q ok
P-132	DI-132	MH-133	4517	1246	5763	0.13	0.78	0.10	0.28	6.0	6.71	5.98	**1.68**	15	56	0.012	0.000580	0.0030	3.1	**3.9**	3.0	0.31	7.02	3.44	3.27	Q ok
P-133	MH-133	DI-134	1	0	1	0.00	0.95	0.00	0.82	6.0	7.02	5.90	**4.83**	24	36	0.012	0.000388	0.0031	4.3	**13.5**	3.9	0.15	7.17	3.17	3.06	Q ok
P-134	DI-134	MH-135	4193	284	4477	0.10	0.90	0.09	0.91	6.0	7.17	5.85	**5.33**	**24**	31	0.012	0.000472	0.0035	4.6	**14.6**	4.2	0.12	7.29	2.96	2.85	Q ok
P-135	MH-135	MH-170	1	0	1	0.00	0.95	0.00	2.04	6.0	7.29	5.83	**11.86**	**30**	94	0.012	0.000713	0.0039	5.7	**27.9**	5.5	0.28	7.58	2.67	2.30	Q ok
P-136	B3 South	MH-133	24569	0	24569	0.56	0.95	0.54	0.54	6.0	0.00	6.16	**3.30**	18	17	0.012	0.000842	0.0047	4.4	**7.8**	4.1	0.07	6.07	3.36	3.28	Q ok
P-144	DI-144	MH-145	2618	65	2683	0.06	0.93	0.06	0.06	6.0	0.00	6.16	**0.35**	15	55	0.012	0.000026	0.0051	4.1	**5.0**	2.0	0.46	6.46	3.79	3.51	Q ok
P-145	MH-145	DI-146	1	0	1	0.00	0.95	0.00	0.59	6.0	6.46	6.03	**3.58**	18	39	0.012	0.000989	0.0049	4.5	**7.9**	4.4	0.15	6.61	3.41	3.22	Q ok
P-146	DI-146	DI-147	3675	195	3870	0.09	0.91	0.08	0.67	6.0	6.61	6.01	**4.05**	18	68	0.012	0.001267	0.0050	4.6	**8.0**	4.5	0.25	6.86	3.12	2.78	Q ok
P-147	DI-147	DI-143	5191	266	5457	0.13	0.91	0.11	0.79	6.0	6.86	5.93	**4.68**	18	25	0.012	0.001688	0.0052	4.6	**8.2**	4.7	0.09	6.95	2.68	2.55	Q ok
P-148	B3 West	MH-145	24569	0	24569	0.56	0.95	0.54	0.54	6.0	0.00	6.16	**3.30**	18	17	0.012	0.000842	0.0053	4.7	**8.3**	4.3	0.07	6.07	3.60	3.51	Q ok
P-167	DI-167	DI-159	3909	227	4136	0.09	0.91	0.09	0.09	6.0	6.00	4.01	**0.35**	15	18	0.012	0.000024	0.0033	3.3	**4.0**	2.0	0.15	6.15	4.29	4.23	Q ok
P-159	DI-159	DI-150	3909	227	4136	0.09	0.91	0.09	0.17	6.0	6.15	3.98	**0.69**	15	100	0.012	0.000096	0.0053	4.2	**5.1**	2.9	0.57	6.73	4.13	3.60	Q ok
P-150	DI-150	MH-151	3037	0	3037	0.07	0.95	0.07	0.24	6.0	0.00	6.16	**1.47**	15	24	0.012	0.000441	0.0042	3.7	**4.5**	3.3	0.12	6.12	3.50	3.40	Q ok
P-151	MH-151	DI-152	1	0	1	0.00	0.95	0.00	1.58	6.0	6.12	6.14	**9.72**	24	51	0.012	0.001572	0.0039	4.9	**15.3**	5.2	0.16	6.28	3.30	3.10	Q ok
P-153	B1	MH-151	61668	0	61668	1.42	0.95	1.34	1.34	6.0	0.00	6.16	**8.29**	24	17	0.012	0.001143	0.0100	7.8	**24.5**	7.0	0.04	6.04	3.57	3.40	Q ok
P-157	B3 North	MH-155	24569	0	24569	0.56	0.95	0.54	0.54	6.0	0.00	6.16	**3.30**	18	18	0.012	0.000842	0.0050	4.6	**8.0**	4.2	0.07	6.07	3.72	3.63	Q ok
P-166	B2 North	MH-163	21657	0	21657	0.50	0.95	0.47	0.47	6.0	0.00	6.16	**2.91**	18	50	0.012	0.000654	0.0050	4.6	**8.0**	4.1	0.20	6.20	3.62	3.37	Q ok
P-163	MH-163	MH-140	1	0	1	0.00	0.95	0.00	1.24	6.0	6.20	6.11	**7.60**	18	44	0.012	0.004463	0.0150	7.9	**13.9**	8.0	0.09	6.29	3.27	2.61	Q ok

KEY	
	Upsized from Semi-Final Design to have capacity for 50-yr design storm
	Optional Upsize-50-yr design storm results in >85% Full
	No Change from Semi-Final Design

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D — 0.8D (ft)	Tailwater, link to Inlet WSE of downstream pipe — TW (ft)	Outlet W. S. Elevation — HGL Dn (ft)	Outflow Pipe Diameter — D_o (in)	Outflow Pipe Design Flow — Q_o (cfs)	Pressure-flow Vel., $V_o=Q_o/A$ — V_o (fps)	Skew angle vs. — Δ_o (deg)	Outflow Pipe Length — L (ft)	Friction Slope — S_{fo} (ft/ft)	Friction Loss — H_f (ft)	Angle of Curvat — O (deg)	Curved align; add $Hc = 0.002*O*V_o^2/2g$ — H_c (ft)	Contraction Loss — H_o (ft)	Q*V for determining controlling inflow pipe — Q1V1 (ft^4/s^2)	Q*V for determining controlling inflow pipe — Q2V2 (ft^4/s^2)	Q*V for determining controlling inflow pipe — Q3V3 (ft^4/s^2)	Controlling Inflow Velocity — Vi	Expansion Loss — Hi (ft)	Controlling In-flow skew — Δ_i (deg)	Bend Loss — H_Δ (ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ — H_t (cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss — $H_{t\,adj}$ (ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ — H (ft)	Inlet W. S. Elevation — HGL Up (ft)	Top of Grate — T/G (ft)	HGL Check
P-158	DI-158	DI-154	1.00	5.18	5.18	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.19	7.70	HGL ok
P-154	DI-154	MH-155	1.00	5.17	5.17	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.18	9.06	HGL ok
P-155	MH-155	DI-156	1.20	5.06	5.06	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	5.17	10.06	HGL ok
P-156	DI-156	DI-152	1.20	4.89	4.89	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	5.06	11.07	HGL ok
P-152	DI-152	MH-140	2.00	4.69	4.69	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	4.89	11.07	HGL ok
P-140	MH-140	DI-141	2.40	4.32	4.52	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	4.69	12.04	HGL ok
P-141	DI-141	DI-142	2.40	4.15	4.15	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	4.32	11.02	HGL ok
P-142	DI-142	DI-143	2.40	4.00	4.00	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	4.15	10.52	HGL ok
P-143	DI-143	MH-170	2.40	3.78	3.78	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	4.00	10.28	HGL ok
P-170	MH-170	MH-171	3.20	3.59	3.59	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	3.78	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.48	3.48	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	3.59	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.36	3.36	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	3.48	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.20**	**3.20**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**3.36**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	3.59	3.59	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.59	10.61	HGL ok
P-175	DI-175	MH-171	1.20	3.59	3.59	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.59	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.48	3.48	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	3.53	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.48	3.48	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	3.53	10.00	HGL ok
P-178	TD-03	DI-179	0.53	3.60	6.23	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	6.65	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.36	3.36	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	3.60	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.42	6.78	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	6.86	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.36	3.36	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	3.42	9.25	HGL ok
P-115	B5 West	MH-116	1.20	5.49	5.49	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	5.52	10.00	HGL ok
P-116	MH-116	DI-117	1.20	5.33	5.33	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	5.49	11.99	HGL ok
P-117	DI-117	DI-118	1.20	5.13	5.13	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	5.33	11.71	HGL ok
P-118	DI-118	DI-113	1.20	4.92	4.92	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	5.13	11.30	HGL ok
P-113	DI-113	DI-114	1.20	4.44	4.44	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	4.92	11.30	HGL ok
P-114	DI-114	MH-170	1.20	3.78	3.78	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	4.44	10.75	HGL ok
P-110	B4 South	MH-111	1.20	5.10	5.10	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	5.12	10.00	HGL ok
P-111	MH-111	DI-112	1.20	5.02	5.02	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	5.10	11.99	HGL ok
P-112	DI-112	DI-113	1.20	4.92	4.92	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	5.02	11.71	HGL ok
P-120	DI-120	DI-121	1.00	4.79	4.89	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-121	DI-121	DI-122	1.00	4.76	4.76	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	4.79	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.71	4.71	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	4.76	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.51	4.63	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	4.71	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.41	4.41	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	4.51	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.51	4.51	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.51	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.71	4.71	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	4.75	10.00	HGL ok
P-130	DI-130	DI-131	1.00	4.78	4.89	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.76	4.76	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	4.78	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.71	4.71	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	4.76	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.51	4.66	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	4.71	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.41	4.45	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	4.51	9.44	HGL ok
P-135	MH-135	MH-170	2.00	3.78	4.30	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	4.41	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.71	4.71	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	4.73	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	4.49	4.51	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.51	11.02	HGL ok
P-145	MH-145	DI-146	1.20	4.34	4.42	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	4.49	10.87	HGL ok
P-146	DI-146	DI-147	1.20	4.19	4.19	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	4.34	10.52	HGL ok
P-147	DI-147	DI-143	1.20	4.00	4.00	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	4.19	10.28	HGL ok
P-148	B3 West	MH-145	1.20	4.49	4.71	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	4.73	10.00	HGL ok
P-167	DI-167	DI-159	1.00	5.13	5.23	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.23	7.48	HGL ok
P-159	DI-159	DI-150	1.00	5.07	5.07	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	5.13	7.70	HGL ok
P-150	DI-150	MH-151	1.00	5.05	5.05	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	5.07	9.06	HGL ok
P-151	MH-151	DI-152	1.60	4.89	4.89	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	5.05	10.06	HGL ok
P-153	B1	MH-151	1.60	5.05	5.05	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	5.09	10.00	HGL ok
P-157	B3 North	MH-155	1.20	5.17	5.17	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	5.19	10.00	HGL ok
P-166	B2 North	MH-163	1.20	4.96	4.96	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	5.00	10.00	HGL ok
P-163	MH-163	MH-140	1.20	4.69	4.69	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	4.96	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location No.	Location From	Location To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add $Hc = 0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	5.18	5.18	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.19	7.70	HGL ok
P-154	DI-154	MH-155	1.00	5.17	5.17	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.18	9.06	HGL ok
P-155	MH-155	DI-156	1.20	5.06	5.06	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	5.17	10.06	HGL ok
P-156	DI-156	DI-152	1.20	4.90	4.90	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	5.06	11.07	HGL ok
P-152	DI-152	MH-140	2.00	4.69	4.69	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	4.90	11.07	HGL ok
P-140	MH-140	DI-141	2.40	4.52	4.52	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	4.69	12.04	HGL ok
P-141	DI-141	DI-142	2.40	4.35	4.35	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	4.52	11.02	HGL ok
P-142	DI-142	DI-143	2.40	4.20	4.20	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	4.35	10.52	HGL ok
P-143	DI-143	MH-170	2.40	3.98	3.98	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	4.20	10.28	HGL ok
P-170	MH-170	MH-171	3.20	3.79	3.79	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	3.98	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.68	3.68	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	3.79	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.56	3.56	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	3.68	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.40**	**3.40**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**3.56**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	3.79	3.79	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.79	10.61	HGL ok
P-175	DI-175	MH-171	1.20	3.79	3.79	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.79	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.68	3.68	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	3.73	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.68	3.68	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	3.73	10.00	HGL ok
P-178	TD-03	DI-179	0.53	3.80	6.23	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	6.65	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.56	3.56	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	3.80	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.62	6.78	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	6.86	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.56	3.56	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	3.62	9.25	HGL ok
P-115	B5 West	MH-116	1.20	5.69	5.69	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	5.72	10.00	HGL ok
P-116	MH-116	DI-117	1.20	5.53	5.53	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	5.69	11.99	HGL ok
P-117	DI-117	DI-118	1.20	5.33	5.33	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	5.53	11.71	HGL ok
P-118	DI-118	DI-113	1.20	5.12	5.12	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	5.33	11.30	HGL ok
P-113	DI-113	DI-114	1.20	4.64	4.64	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	5.12	11.30	HGL ok
P-114	DI-114	MH-170	1.20	3.98	3.98	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	4.64	10.75	HGL ok
P-110	B4 South	MH-111	1.20	5.30	5.30	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	5.32	10.00	HGL ok
P-111	MH-111	DI-112	1.20	5.22	5.22	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	5.30	11.99	HGL ok
P-112	DI-112	DI-113	1.20	5.12	5.12	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	5.22	11.71	HGL ok
P-120	DI-120	DI-121	1.00	4.79	4.89	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-121	DI-121	DI-122	1.00	4.76	4.76	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	4.79	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.71	4.71	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	4.76	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.51	4.63	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	4.71	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.41	4.41	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	4.51	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.51	4.51	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.51	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.71	4.71	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	4.75	10.00	HGL ok
P-130	DI-130	DI-131	1.00	4.78	4.89	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.76	4.76	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	4.78	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.71	4.71	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	4.76	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.51	4.66	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	4.71	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.41	4.45	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	4.51	9.44	HGL ok
P-135	MH-135	MH-170	2.00	3.98	4.30	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	4.41	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.71	4.71	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	4.73	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	4.61	4.61	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.62	11.02	HGL ok
P-145	MH-145	DI-146	1.20	4.54	4.54	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	4.61	10.87	HGL ok
P-146	DI-146	DI-147	1.20	4.39	4.39	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	4.54	10.52	HGL ok
P-147	DI-147	DI-143	1.20	4.20	4.20	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	4.39	10.28	HGL ok
P-148	B3 West	MH-145	1.20	4.61	4.71	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	4.73	10.00	HGL ok
P-167	DI-167	DI-159	1.00	5.13	5.23	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.23	7.48	HGL ok
P-159	DI-159	DI-150	1.00	5.07	5.07	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	5.13	7.70	HGL ok
P-150	DI-150	MH-151	1.00	5.05	5.05	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	5.07	9.06	HGL ok
P-151	MH-151	DI-152	1.60	4.90	4.90	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	5.05	10.06	HGL ok
P-153	B1	MH-151	1.60	5.05	5.05	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	5.09	10.00	HGL ok
P-157	B3 North	MH-155	1.20	5.17	5.17	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	5.19	10.00	HGL ok
P-166	B2 North	MH-163	1.20	4.97	4.97	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	5.00	10.00	HGL ok
P-163	MH-163	MH-140	1.20	4.69	4.69	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	4.97	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 10 -year (50-year for sumps)

Location No.	Location From	Location To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\ adj}$ ft	Tot. H Loss, $H = H_f + H_{t\ adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	8.68	8.68	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.69	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	8.67	8.67	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.68	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	8.56	8.56	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	8.67	10.06	HGL ok
P-156	DI-156	DI-152	1.20	8.40	8.40	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	8.56	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.19	8.19	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	8.40	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.02	8.02	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	8.19	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.85	7.85	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	8.02	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.70	7.70	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	7.85	10.52	HGL ok
P-143	DI-143	MH-170	2.40	7.48	7.48	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	7.70	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.29	7.29	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	7.48	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.18	7.18	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	7.29	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.06	7.06	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	7.18	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**7.06**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.29	7.29	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.29	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.29	7.29	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.29	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.18	7.18	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	7.23	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.18	7.18	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	7.23	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.30	7.30	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	7.72	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.06	7.06	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	7.30	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.12	7.12	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	7.20	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.06	7.06	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	7.12	9.25	HGL ok
P-115	B5 West	MH-116	1.20	9.19	9.19	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.22	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.03	9.03	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	9.19	11.99	HGL ok
P-117	DI-117	DI-118	1.20	8.83	8.83	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	9.03	11.71	HGL ok
P-118	DI-118	DI-113	1.20	8.62	8.62	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	8.83	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.14	8.14	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	8.62	11.30	HGL ok
P-114	DI-114	MH-170	1.20	7.48	7.48	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	8.14	10.75	HGL ok
P-110	B4 South	MH-111	1.20	8.80	8.80	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	8.82	10.00	HGL ok
P-111	MH-111	DI-112	1.20	8.72	8.72	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	8.80	11.99	HGL ok
P-112	DI-112	DI-113	1.20	8.62	8.62	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	8.72	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.85	7.85	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.85	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.82	7.82	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	7.85	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.77	7.77	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	7.82	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.69	7.69	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	7.77	8.91	HGL ok
P-124	DI-124	MH-135	1.60	7.60	7.60	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	7.69	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.69	7.69	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.69	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.77	7.77	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	7.81	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.78	7.78	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.78	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.75	7.75	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	7.78	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.71	7.71	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	7.75	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.66	7.66	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	7.71	8.91	HGL ok
P-134	DI-134	MH-135	1.60	7.60	7.60	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	7.66	9.44	HGL ok
P-135	MH-135	MH-170	2.00	7.48	7.48	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	7.60	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.71	7.71	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	7.73	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.11	8.11	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.12	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.04	8.04	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	8.11	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.89	7.89	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	8.04	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.70	7.70	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	7.89	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.11	8.11	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	8.14	10.00	HGL ok
P-167	DI-167	DI-159	1.00	8.63	8.63	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.64	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	8.57	8.57	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	8.63	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	8.55	8.55	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.57	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.40	8.40	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	8.55	10.06	HGL ok
P-153	B1	MH-151	1.60	8.55	8.55	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	8.59	10.00	HGL ok
P-157	B3 North	MH-155	1.20	8.67	8.67	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	8.69	10.00	HGL ok
P-166	B2 North	MH-163	1.20	8.47	8.47	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	8.50	10.00	HGL ok
P-163	MH-163	MH-140	1.20	8.19	8.19	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	8.47	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	9.18	9.18	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.19	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.17	9.17	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.18	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.06	9.06	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	9.17	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	8.90	8.90	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	9.06	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.69	8.69	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	8.90	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.52	8.52	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	8.69	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.35	8.35	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	8.52	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.20	8.20	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	8.35	10.52	HGL ok
P-143	DI-143	MH-170	2.40	7.98	7.98	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	8.20	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.79	7.79	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	7.98	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.68	7.68	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	7.79	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.56	7.56	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	7.68	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**7.56**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.79	7.79	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.79	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.79	7.79	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.79	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.68	7.68	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	7.73	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.68	7.68	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	7.73	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.80	7.80	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	8.22	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.56	7.56	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	7.80	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.62	7.62	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	7.70	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.56	7.56	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	7.62	9.25	HGL ok
P-115	B5 West	MH-116	1.20	9.69	9.69	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.72	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.53	9.53	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	9.69	11.99	HGL ok
P-117	DI-117	DI-118	1.20	9.33	9.33	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	9.53	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.12	9.12	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	9.33	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.64	8.64	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	9.12	11.30	HGL ok
P-114	DI-114	MH-170	1.20	7.98	7.98	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	8.64	10.75	HGL ok
P-110	B4 South	MH-111	1.20	9.30	9.30	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	9.32	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.22	9.22	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	9.30	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.12	9.12	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	9.22	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.35	8.35	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.35	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.32	8.32	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	8.35	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.27	8.27	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	8.32	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.19	8.19	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	8.27	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.10	8.10	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	8.19	9.44	HGL ok
P-125	DI-125	DI-124	1.00	8.19	8.19	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.19	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.27	8.27	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	8.31	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.28	8.28	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.28	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.25	8.25	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	8.28	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.21	8.21	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	8.25	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.16	8.16	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	8.21	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.10	8.10	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	8.16	9.44	HGL ok
P-135	MH-135	MH-170	2.00	7.98	7.98	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	8.10	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.21	8.21	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	8.23	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.61	8.61	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.62	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.54	8.54	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	8.61	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.39	8.39	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	8.54	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.20	8.20	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	8.39	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.61	8.61	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	8.64	10.00	HGL ok
P-167	DI-167	DI-159	1.00	9.13	9.13	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.14	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.07	9.07	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	9.13	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.05	9.05	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.07	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.90	8.90	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	9.05	10.06	HGL ok
P-153	B1	MH-151	1.60	9.05	9.05	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	9.09	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	9.17	9.17	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	9.19	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	8.97	8.97	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	9.00	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	8.69	8.69	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	8.97	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR
County:	New Castle	Checked by:	TMC
Segment:	East Bank Blvd Outfall	Design Freq.:	10

Date: 2/23/23 Sheet No.: 3 of 5
Date: 3/23/23 Cm. No.: 20077
-year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	9.58	9.58	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.59	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.57	9.57	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.58	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.46	9.46	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	9.57	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	9.30	9.30	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	9.46	11.07	HGL ok
P-152	DI-152	MH-140	2.00	9.09	9.09	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	9.30	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.92	8.92	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	9.09	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.75	8.75	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	8.92	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.60	8.60	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	8.75	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.38	8.38	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	8.60	10.28	HGL ok
P-170	MH-170	MH-171	3.20	8.19	8.19	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	8.38	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.08	8.08	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	8.19	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.96	7.96	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	8.08	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**7.96**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.19	8.19	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.19	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.19	8.19	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.19	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.08	8.08	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	8.13	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.08	8.08	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	8.13	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.20	8.20	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	8.62	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.96	7.96	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	8.20	9.25	HGL ok
P-180	TD-02	DI-181	0.53	8.02	8.02	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	8.10	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.96	7.96	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	8.02	9.25	HGL ok
P-115	B5 West	MH-116	1.20	10.09	10.09	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.12	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.93	9.93	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	10.09	11.99	HGL ok
P-117	DI-117	DI-118	1.20	9.73	9.73	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	9.93	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.52	9.52	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	9.73	11.30	HGL ok
P-113	DI-113	DI-114	1.20	9.04	9.04	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	9.52	11.30	HGL ok
P-114	DI-114	MH-170	1.20	8.38	8.38	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	9.04	10.75	HGL ok
P-110	B4 South	MH-111	1.20	9.70	9.70	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	9.72	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.62	9.62	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	9.70	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.52	9.52	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	9.62	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.75	8.75	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.75	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.72	8.72	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	8.75	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.67	8.67	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	8.72	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.59	8.59	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	8.67	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.50	8.50	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	8.59	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	8.59	8.59	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.59	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.67	8.67	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	8.71	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.68	8.68	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.68	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.65	8.65	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	8.68	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.61	8.61	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	8.65	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.56	8.56	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	8.61	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.50	8.50	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	8.56	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.38	8.38	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	8.50	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.61	8.61	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	8.63	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.01	9.01	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.02	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.94	8.94	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	9.01	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.79	8.79	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	8.94	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.60	8.60	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	8.79	10.28	HGL ok
P-148	B3 West	MH-145	1.20	9.01	9.01	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	9.04	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	9.53	9.53	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.54	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.47	9.47	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	9.53	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.45	9.45	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.47	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	9.30	9.30	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	9.45	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.45	9.45	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	9.49	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	9.57	9.57	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	9.59	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.37	9.37	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	9.40	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.09	9.09	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	9.37	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 10 -year (50-year for sumps)

Date: 2/23/23 Sheet No.: 3 of 5
Date: 3/23/23 Cm. No.: 20077

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	10.08	10.08	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.09	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.07	10.07	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.08	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.96	9.96	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	10.07	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	9.80	9.80	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	9.96	11.07	HGL ok
P-152	DI-152	MH-140	2.00	9.59	9.59	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	9.80	11.07	HGL ok
P-140	MH-140	DI-141	2.40	9.42	9.42	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	9.59	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.25	9.25	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	9.42	11.02	HGL ok
P-142	DI-142	DI-143	2.40	9.10	9.10	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	9.25	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.88	8.88	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	9.10	10.28	HGL ok
P-170	MH-170	MH-171	3.20	8.69	8.69	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	8.88	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.58	8.58	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	8.69	10.83	HGL ok
P-172	MH-172	MH-173	3.20	8.46	8.46	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	8.58	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**8.46**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.69	8.69	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.69	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.69	8.69	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.69	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.58	8.58	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	8.63	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.58	8.58	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	8.63	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.70	8.70	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	9.12	10.50	HGL ok
P-179	DI-179	MH-173	1.00	8.46	8.46	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	8.70	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	8.52	8.52	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	8.60	10.50	HGL ok
P-181	DI-181	MH-173	1.00	8.46	8.46	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	8.52	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	10.59	10.59	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.62	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.43	10.43	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	10.59	11.99	HGL ok
P-117	DI-117	DI-118	1.20	10.23	10.23	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	10.43	11.71	HGL ok
P-118	DI-118	DI-113	1.20	10.02	10.02	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	10.23	11.30	HGL ok
P-113	DI-113	DI-114	1.20	9.54	9.54	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	10.02	11.30	HGL ok
P-114	DI-114	MH-170	1.20	8.88	8.88	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	9.54	10.75	HGL ok
P-110	B4 South	MH-111	1.20	10.20	10.20	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.22	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.12	10.12	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	10.20	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.02	10.02	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	10.12	11.71	HGL ok
P-120	DI-120	DI-121	1.00	9.25	9.25	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.25	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.22	9.22	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	9.25	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.17	9.17	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	9.22	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.09	9.09	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	9.17	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.00	9.00	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	9.09	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.09	9.09	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.09	10.67	HGL ok
P-126	B5 North	MH-123	1.20	9.17	9.17	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	9.21	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.18	9.18	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.18	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.15	9.15	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	9.18	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.11	9.11	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	9.15	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.06	9.06	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	9.11	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.00	9.00	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	9.06	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.88	8.88	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	9.00	10.15	HGL ok
P-136	B3 South	MH-133	1.20	9.11	9.11	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	9.13	10.00	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.51	9.51	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.52	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.44	9.44	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	9.51	10.87	HGL ok
P-146	DI-146	DI-147	1.20	9.29	9.29	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	9.44	10.52	HGL ok
P-147	DI-147	DI-143	1.20	9.10	9.10	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	9.29	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	9.51	9.51	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	9.54	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.03	10.03	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.04	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.97	9.97	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.03	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.95	9.95	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.97	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	9.80	9.80	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	9.95	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.95	9.95	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	9.99	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.07	10.07	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.09	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.87	9.87	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	9.90	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.59	9.59	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	9.87	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by: TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.: 10	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	10.78	10.78	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.79	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.77	10.77	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.78	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.66	10.66	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	10.77	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.50	10.50	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	10.66	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.29	10.29	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	10.50	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.12	10.12	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	10.29	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.95	9.95	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	10.12	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	9.80	9.80	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	9.95	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.58	9.58	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	9.80	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.39	9.39	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	9.58	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.28	9.28	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	9.39	10.83	HGL ok
P-172	MH-172	MH-173	3.20	9.16	9.16	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	9.28	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**9.16**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	9.39	9.39	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.39	10.61	HGL ok
P-175	DI-175	MH-171	1.20	9.39	9.39	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.39	10.63	HGL ok
P-176	B4 North	MH-172	1.20	9.28	9.28	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	9.33	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.28	9.28	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	9.33	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.40	9.40	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	9.82	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.16	9.16	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	9.40	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.22	9.22	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	9.30	10.50	HGL ok
P-181	DI-181	MH-173	1.00	9.16	9.16	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	9.22	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	11.29	11.29	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.32	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.13	11.13	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	11.29	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	10.93	10.93	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	11.13	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	10.72	10.72	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	10.93	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.24	10.24	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	10.72	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	9.58	9.58	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	10.24	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	10.90	10.90	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.92	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.82	10.82	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	10.90	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.72	10.72	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	10.82	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	9.95	9.95	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.95	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.92	9.92	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	9.95	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.87	9.87	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	9.92	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.79	9.79	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	9.87	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.70	9.70	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	9.79	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.79	9.79	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.79	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	9.87	9.87	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	9.91	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.88	9.88	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.88	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.85	9.85	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	9.88	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.81	9.81	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	9.85	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.76	9.76	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	9.81	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.70	9.70	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	9.76	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.58	9.58	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	9.70	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	9.81	9.81	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	9.83	10.00	HGL Too High!

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Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.21	10.21	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.22	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.14	10.14	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	10.21	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	9.99	9.99	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	10.14	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.80	9.80	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	9.99	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.21	10.21	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.24	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.73	10.73	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.74	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.67	10.67	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.73	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.65	10.65	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.67	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.50	10.50	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	10.65	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.65	10.65	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	10.69	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.77	10.77	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.79	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.57	10.57	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	10.60	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.29	10.29	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	10.57	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	11.28	11.28	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.29	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.27	11.27	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.28	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.16	11.16	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	11.27	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.00	11.00	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	11.16	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.79	10.79	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	11.00	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.62	10.62	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	10.79	12.04	HGL ok
P-141	DI-141	DI-142	2.40	10.45	10.45	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	10.62	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.30	10.30	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	10.45	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.08	10.08	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	10.30	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.89	9.89	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	10.08	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.78	9.78	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	9.89	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.66	9.66	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	9.78	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**9.66**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	9.89	9.89	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.89	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	9.89	9.89	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.89	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.78	9.78	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	9.83	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.78	9.78	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	9.83	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.90	9.90	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	10.32	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.66	9.66	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	9.90	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.72	9.72	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	9.80	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.66	9.66	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	9.72	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	11.79	11.79	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.82	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.63	11.63	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	11.79	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.43	11.43	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	11.63	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.22	11.22	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	11.43	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.74	10.74	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	11.22	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.08	10.08	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	10.74	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.40	11.40	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.42	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.32	11.32	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	11.40	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.22	11.22	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	11.32	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.45	10.45	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.45	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.42	10.42	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	10.45	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.37	10.37	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	10.42	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.29	10.29	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	10.37	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.20	10.20	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	10.29	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.29	10.29	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.29	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.37	10.37	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	10.41	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.38	10.38	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.38	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.35	10.35	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	10.38	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.31	10.31	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	10.35	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.26	10.26	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	10.31	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.20	10.20	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	10.26	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.08	10.08	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	10.20	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.31	10.31	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.33	10.00	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.71	10.71	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.72	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.64	10.64	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	10.71	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.49	10.49	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	10.64	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.30	10.30	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	10.49	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.71	10.71	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.74	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.23	11.23	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.24	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.17	11.17	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.23	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.15	11.15	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.17	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.00	11.00	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	11.15	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.15	11.15	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	11.19	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.27	11.27	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.29	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.07	11.07	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	11.10	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.79	10.79	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	11.07	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Hi= H_Δ +H_t +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.58	12.58	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.59	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.57	12.57	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.58	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.46	12.46	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	12.57	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.30	12.30	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	12.46	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.09	12.09	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	12.30	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.92	11.92	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	12.09	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.75	11.75	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	11.92	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.60	11.60	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	11.75	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.38	11.38	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	11.60	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.19	11.19	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	11.38	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.08	11.08	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	11.19	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.96	10.96	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	11.08	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**10.96**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.19	11.19	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.19	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.19	11.19	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.19	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.08	11.08	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	11.13	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.08	11.08	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	11.13	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.20	11.20	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	11.62	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.96	10.96	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	11.20	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.02	11.02	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	11.10	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.96	10.96	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	11.02	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.09	13.09	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	13.12	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.93	12.93	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	13.09	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.73	12.73	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	12.93	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.52	12.52	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	12.73	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.04	12.04	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	12.52	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.38	11.38	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	12.04	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.70	12.70	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.72	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.62	12.62	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	12.70	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.52	12.52	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	12.62	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.75	11.75	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.75	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.72	11.72	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	11.75	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.67	11.67	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	11.72	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.59	11.59	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	11.67	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.50	11.50	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	11.59	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.59	11.59	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.59	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.67	11.67	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.71	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.68	11.68	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.68	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.65	11.65	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	11.68	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.61	11.61	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	11.65	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.56	11.56	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	11.61	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.50	11.50	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	11.56	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.38	11.38	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	11.50	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.61	11.61	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.63	10.00	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.01	12.01	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.02	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.94	11.94	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	12.01	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.79	11.79	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	11.94	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.60	11.60	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	11.79	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.01	12.01	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.04	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.53	12.53	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.54	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.47	12.47	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.53	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.45	12.45	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.47	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.30	12.30	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	12.45	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.45	12.45	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	12.49	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.57	12.57	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.59	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.37	12.37	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	12.40	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.09	12.09	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	12.37	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Hi= H_Δ +H_t +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	7.52	7.52	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.53	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	7.51	7.51	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.52	9.06	HGL ok
P-155	MH-155	DI-156	1.20	7.40	7.40	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	7.51	10.06	HGL ok
P-156	DI-156	DI-152	1.20	7.24	7.24	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	7.40	11.07	HGL ok
P-152	DI-152	MH-140	2.00	7.03	7.03	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	7.24	11.07	HGL ok
P-140	MH-140	DI-141	2.40	6.86	6.86	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	7.03	12.04	HGL ok
P-141	DI-141	DI-142	2.40	6.69	6.69	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	6.86	11.02	HGL ok
P-142	DI-142	DI-143	2.40	6.54	6.54	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	6.69	10.52	HGL ok
P-143	DI-143	MH-170	2.40	6.32	6.32	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	6.54	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.13	6.13	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	6.32	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.02	6.02	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	6.13	10.83	HGL ok
P-172	MH-172	MH-173	3.20	5.90	5.90	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	6.02	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**5.90**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.13	6.13	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.13	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.13	6.13	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.13	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.02	6.02	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	6.07	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.02	6.02	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	6.07	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.14	6.23	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	6.65	10.50	HGL ok
P-179	DI-179	MH-173	1.00	5.90	5.90	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	6.14	9.25	HGL ok
P-180	TD-02	DI-181	0.53	5.96	6.78	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	6.86	10.50	HGL ok
P-181	DI-181	MH-173	1.00	5.90	5.90	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	5.96	9.25	HGL ok
P-115	B5 West	MH-116	1.20	8.03	8.03	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	8.06	10.00	HGL ok
P-116	MH-116	DI-117	1.20	7.87	7.87	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	8.03	11.99	HGL ok
P-117	DI-117	DI-118	1.20	7.67	7.67	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	7.87	11.71	HGL ok
P-118	DI-118	DI-113	1.20	7.46	7.46	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	7.67	11.30	HGL ok
P-113	DI-113	DI-114	1.20	6.98	6.98	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	7.46	11.30	HGL ok
P-114	DI-114	MH-170	1.20	6.32	6.32	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	6.98	10.75	HGL ok
P-110	B4 South	MH-111	1.20	7.64	7.64	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	7.66	10.00	HGL ok
P-111	MH-111	DI-112	1.20	7.56	7.56	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	7.64	11.99	HGL ok
P-112	DI-112	DI-113	1.20	7.46	7.46	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	7.56	11.71	HGL ok
P-120	DI-120	DI-121	1.00	6.69	6.69	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.69	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	6.66	6.66	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	6.69	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	6.61	6.61	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	6.66	7.81	HGL ok
P-123	MH-123	DI-124	1.60	6.53	6.53	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	6.61	8.91	HGL ok
P-124	DI-124	MH-135	1.60	6.44	6.44	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	6.53	9.44	HGL ok
P-125	DI-125	DI-124	1.00	6.53	6.53	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.53	10.67	HGL ok
P-126	B5 North	MH-123	1.20	6.61	6.61	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	6.65	10.00	HGL ok
P-130	DI-130	DI-131	1.00	6.62	6.62	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.62	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	6.59	6.59	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	6.62	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	6.55	6.55	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	6.59	7.81	HGL ok
P-133	MH-133	DI-134	1.60	6.50	6.50	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	6.55	8.91	HGL ok
P-134	DI-134	MH-135	1.60	6.44	6.44	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	6.50	9.44	HGL ok
P-135	MH-135	MH-170	2.00	6.32	6.32	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	6.44	10.15	HGL ok
P-136	B3 South	MH-133	1.20	6.55	6.55	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	6.57	10.00	HGL ok

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Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	6.95	6.95	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.96	11.02	HGL ok
P-145	MH-145	DI-146	1.20	6.88	6.88	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	6.95	10.87	HGL ok
P-146	DI-146	DI-147	1.20	6.73	6.73	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	6.88	10.52	HGL ok
P-147	DI-147	DI-143	1.20	6.54	6.54	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	6.73	10.28	HGL ok
P-148	B3 West	MH-145	1.20	6.95	6.95	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	6.98	10.00	HGL ok
P-167	DI-167	DI-159	1.00	7.47	7.47	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.48	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	7.41	7.41	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	7.47	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	7.39	7.39	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.41	9.06	HGL ok
P-151	MH-151	DI-152	1.60	7.24	7.24	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	7.39	10.06	HGL ok
P-153	B1	MH-151	1.60	7.39	7.39	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	7.43	10.00	HGL ok
P-157	B3 North	MH-155	1.20	7.51	7.51	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	7.53	10.00	HGL ok
P-166	B2 North	MH-163	1.20	7.31	7.31	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	7.34	10.00	HGL ok
P-163	MH-163	MH-140	1.20	7.03	7.03	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	7.31	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 10 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	7.72	7.72	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.73	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	7.71	7.71	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.72	9.06	HGL ok
P-155	MH-155	DI-156	1.20	7.60	7.60	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	*0.5*	0.04	0.11	7.71	10.06	HGL ok
P-156	DI-156	DI-152	1.20	7.44	7.44	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	7.60	11.07	HGL ok
P-152	DI-152	MH-140	2.00	7.23	7.23	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	7.44	11.07	HGL ok
P-140	MH-140	DI-141	2.40	7.06	7.06	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	*0.5*	0.09	0.17	7.23	12.04	HGL ok
P-141	DI-141	DI-142	2.40	6.89	6.89	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	7.06	11.02	HGL ok
P-142	DI-142	DI-143	2.40	6.74	6.74	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	6.89	10.52	HGL ok
P-143	DI-143	MH-170	2.40	6.52	6.52	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	*0.5*	0.06	0.22	6.74	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.33	6.33	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	*0.5*	0.14	0.19	6.52	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.22	6.22	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	*0.5*	0.06	0.11	6.33	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.10	6.10	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	*0.5*	0.07	0.12	6.22	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	***0.5***	**0.08**	**0.16**	**6.10**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.33	6.33	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.33	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.33	6.33	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.33	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.22	6.22	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.05	6.27	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.22	6.22	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.04	6.27	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.34	6.34	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	6.76	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.10	6.10	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	*1.3*	1.0	0.21	0.24	6.34	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.16	6.78	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	6.86	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.10	6.10	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	*1.3*	1.0	0.05	0.06	6.16	9.25	HGL ok
P-115	B5 West	MH-116	1.20	8.23	8.23	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	8.26	10.00	HGL ok
P-116	MH-116	DI-117	1.20	8.07	8.07	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	*0.5*	0.06	0.16	8.23	11.99	HGL ok
P-117	DI-117	DI-118	1.20	7.87	7.87	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	8.07	11.71	HGL ok
P-118	DI-118	DI-113	1.20	7.66	7.66	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	7.87	11.30	HGL ok
P-113	DI-113	DI-114	1.20	7.18	7.18	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	7.66	11.30	HGL ok
P-114	DI-114	MH-170	1.20	6.52	6.52	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	7.18	10.75	HGL ok
P-110	B4 South	MH-111	1.20	7.84	7.84	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	7.86	10.00	HGL ok
P-111	MH-111	DI-112	1.20	7.76	7.76	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	*0.5*	0.03	0.07	7.84	11.99	HGL ok
P-112	DI-112	DI-113	1.20	7.66	7.66	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	*1.3*	1.0	0.05	0.11	7.76	11.71	HGL ok
P-120	DI-120	DI-121	1.00	6.89	6.89	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.89	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	6.86	6.86	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	*1.3*	1.0	0.01	0.03	6.89	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	6.81	6.81	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	*1.3*	1.0	0.02	0.05	6.86	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	6.73	6.73	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	*0.5*	0.06	0.08	6.81	8.91	HGL ok
P-124	DI-124	MH-135	1.60	6.64	6.64	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	6.73	9.44	HGL ok
P-125	DI-125	DI-124	1.00	6.73	6.73	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.73	10.67	HGL ok
P-126	B5 North	MH-123	1.20	6.81	6.81	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	6.85	10.00	HGL ok
P-130	DI-130	DI-131	1.00	6.82	6.82	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.82	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	6.79	6.79	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.02	6.82	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	6.75	6.75	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	*1.3*	1.0	0.02	0.05	6.79	7.81	HGL ok
P-133	MH-133	DI-134	1.60	6.70	6.70	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	*0.5*	0.03	0.05	6.75	8.91	HGL ok
P-134	DI-134	MH-135	1.60	6.64	6.64	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	6.70	9.44	HGL ok
P-135	MH-135	MH-170	2.00	6.52	6.52	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	*0.5*	0.05	0.11	6.64	10.15	HGL ok
P-136	B3 South	MH-133	1.20	6.75	6.75	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	6.77	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	7.15	7.15	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.16	11.02	HGL ok
P-145	MH-145	DI-146	1.20	7.08	7.08	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	7.15	10.87	HGL ok
P-146	DI-146	DI-147	1.20	6.93	6.93	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	7.08	10.52	HGL ok
P-147	DI-147	DI-143	1.20	6.74	6.74	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	6.93	10.28	HGL ok
P-148	B3 West	MH-145	1.20	7.15	7.15	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	7.18	10.00	HGL ok
P-167	DI-167	DI-159	1.00	7.67	7.67	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.68	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	7.61	7.61	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	7.67	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	7.59	7.59	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.61	9.06	HGL ok
P-151	MH-151	DI-152	1.60	7.44	7.44	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	7.59	10.06	HGL ok
P-153	B1	MH-151	1.60	7.59	7.59	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	7.63	10.00	HGL ok
P-157	B3 North	MH-155	1.20	7.71	7.71	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	7.73	10.00	HGL ok
P-166	B2 North	MH-163	1.20	7.51	7.51	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	7.54	10.00	HGL ok
P-163	MH-163	MH-140	1.20	7.23	7.23	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	7.51	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 10 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	11.22	11.22	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.23	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.21	11.21	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.22	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.10	11.10	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	11.21	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.94	10.94	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	11.10	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.73	10.73	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	10.94	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.56	10.56	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	10.73	12.04	HGL ok
P-141	DI-141	DI-142	2.40	10.39	10.39	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	10.56	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.24	10.24	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	10.39	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.02	10.02	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	10.24	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.83	9.83	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	10.02	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.72	9.72	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	9.83	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.60	9.60	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	9.72	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**9.60**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	9.83	9.83	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.83	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	9.83	9.83	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.83	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.72	9.72	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	9.77	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.72	9.72	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	9.77	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.84	9.84	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	10.26	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.60	9.60	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	9.84	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.66	9.66	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	9.74	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.60	9.60	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	9.66	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	11.73	11.73	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.76	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.57	11.57	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	11.73	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.37	11.37	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	11.57	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.16	11.16	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	11.37	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.68	10.68	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	11.16	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.02	10.02	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	10.68	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.34	11.34	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.36	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.26	11.26	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	11.34	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.16	11.16	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	11.26	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.39	10.39	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.39	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.36	10.36	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	10.39	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.31	10.31	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	10.36	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.23	10.23	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	10.31	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.14	10.14	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	10.23	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.23	10.23	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.23	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.31	10.31	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	10.35	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.32	10.32	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.32	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.29	10.29	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	10.32	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.25	10.25	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	10.29	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.20	10.20	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	10.25	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.14	10.14	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	10.20	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.02	10.02	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	10.14	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.25	10.25	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.27	10.00	HGL Too High!

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Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.65	10.65	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.66	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.58	10.58	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	10.65	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.43	10.43	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	10.58	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.24	10.24	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	10.43	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.65	10.65	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	10.68	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.17	11.17	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.18	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.11	11.11	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.17	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.09	11.09	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.11	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.94	10.94	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	11.09	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.09	11.09	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	11.13	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.21	11.21	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.23	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.01	11.01	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	11.04	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.73	10.73	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	11.01	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 10 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

Location No.	Location From	Location To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D	Tailwater, link to Inlet WSE of downstream pipe TW	Outlet W. S. Elevation HGL Dn	Outflow Pipe Diameter D_o	Outflow Pipe Design Flow Q_o	Pressure-flow Vel., $V_o=Q_o/A$ V_o	Skew angle vs. Δ_o	Outflow Pipe Length L	Friction Slope S_{fo}	Friction Loss H_f	Angle of Curvat O	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c	Contraction Loss H_o	Q*V for determining controlling inflow pipe Q1V1	Q*V for determining controlling inflow pipe Q2V2	Q*V for determining controlling inflow pipe Q3V3	Controlling Inflow Velocity Vi	Expansion Loss Hi	Controlling In-flow skew Δ_i	Bend Loss H_Δ	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\ adj}$	Tot. H Loss, $H=H_f+H_{t\ adj}$ H	Inlet W. S. Elevation HGL Up	Top of Grate T/G	HGL Check
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	11.72	11.72	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.73	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.71	11.71	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.72	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.60	11.60	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	*0.5*	0.04	0.11	11.71	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.44	11.44	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	11.60	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.23	11.23	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	11.44	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.06	11.06	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	*0.5*	0.09	0.17	11.23	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	10.89	10.89	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	11.06	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.74	10.74	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	10.89	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.52	10.52	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	*0.5*	0.06	0.22	10.74	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.33	10.33	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	*0.5*	0.14	0.19	10.52	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.22	10.22	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	*0.5*	0.06	0.11	10.33	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.10	10.10	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	*0.5*	0.07	0.12	10.22	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	***0.5***	**0.08**	**0.16**	**10.10**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.33	10.33	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.33	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.33	10.33	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.33	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.22	10.22	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.05	10.27	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.22	10.22	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.04	10.27	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.34	10.34	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	10.76	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.10	10.10	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	*1.3*	1.0	0.21	0.24	10.34	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.16	10.16	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	10.24	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.10	10.10	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	*1.3*	1.0	0.05	0.06	10.16	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.23	12.23	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	12.26	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.07	12.07	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	*0.5*	0.06	0.16	12.23	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.87	11.87	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	12.07	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.66	11.66	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	11.87	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.18	11.18	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	11.66	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.52	10.52	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	11.18	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.84	11.84	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	11.86	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.76	11.76	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	*0.5*	0.03	0.07	11.84	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.66	11.66	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	*1.3*	1.0	0.05	0.11	11.76	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.89	10.89	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.89	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.86	10.86	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	*1.3*	1.0	0.01	0.03	10.89	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.81	10.81	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	*1.3*	1.0	0.02	0.05	10.86	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.73	10.73	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	*0.5*	0.06	0.08	10.81	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.64	10.64	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	10.73	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.73	10.73	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.73	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.81	10.81	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	10.85	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.82	10.82	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.82	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.79	10.79	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.02	10.82	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.75	10.75	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	*1.3*	1.0	0.02	0.05	10.79	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.70	10.70	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	*0.5*	0.03	0.05	10.75	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.64	10.64	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	10.70	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.52	10.52	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	*0.5*	0.05	0.11	10.64	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.75	10.75	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	10.77	10.00	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.15	11.15	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.16	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.08	11.08	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	11.15	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.93	10.93	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	11.08	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.74	10.74	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	10.93	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.15	11.15	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.18	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.67	11.67	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.68	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.61	11.61	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.67	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.59	11.59	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.61	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.44	11.44	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	11.59	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.59	11.59	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	11.63	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.71	11.71	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.73	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.51	11.51	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	11.54	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.23	11.23	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	11.51	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H=H_f+H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	**HGL Check**
P-158	DI-158	DI-154	1.00	12.12	12.12	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.13	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.11	12.11	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.12	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.00	12.00	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	*0.5*	0.04	0.11	12.11	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.84	11.84	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	12.00	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.63	11.63	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	11.84	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.46	11.46	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	*0.5*	0.09	0.17	11.63	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.29	11.29	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	11.46	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.14	11.14	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	11.29	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.92	10.92	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	*0.5*	0.06	0.22	11.14	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.73	10.73	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	*0.5*	0.14	0.19	10.92	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.62	10.62	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	*0.5*	0.06	0.11	10.73	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.50	10.50	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	*0.5*	0.07	0.12	10.62	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	***0.5***	**0.08**	**0.16**	**10.50**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.73	10.73	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.73	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.73	10.73	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.73	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.62	10.62	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.05	10.67	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.62	10.62	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.04	10.67	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.74	10.74	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	11.16	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.50	10.50	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	*1.3*	1.0	0.21	0.24	10.74	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.56	10.56	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	10.64	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.50	10.50	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	*1.3*	1.0	0.05	0.06	10.56	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.63	12.63	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	12.66	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.47	12.47	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	*0.5*	0.06	0.16	12.63	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.27	12.27	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	12.47	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.06	12.06	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	12.27	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.58	11.58	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	12.06	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.92	10.92	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	11.58	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.24	12.24	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	12.26	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.16	12.16	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	*0.5*	0.03	0.07	12.24	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.06	12.06	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	*1.3*	1.0	0.05	0.11	12.16	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.29	11.29	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.29	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.26	11.26	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	*1.3*	1.0	0.01	0.03	11.29	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.21	11.21	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	*1.3*	1.0	0.02	0.05	11.26	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.13	11.13	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	*0.5*	0.06	0.08	11.21	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.04	11.04	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	11.13	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.13	11.13	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.13	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.21	11.21	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	11.25	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.22	11.22	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.22	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.19	11.19	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.02	11.22	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.15	11.15	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	*1.3*	1.0	0.02	0.05	11.19	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.10	11.10	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	*0.5*	0.03	0.05	11.15	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.04	11.04	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	11.10	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.92	10.92	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	*0.5*	0.05	0.11	11.04	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.15	11.15	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	11.17	10.00	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.55	11.55	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.56	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.48	11.48	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	11.55	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.33	11.33	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	11.48	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.14	11.14	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	11.33	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.55	11.55	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.58	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.07	12.07	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.08	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.01	12.01	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.07	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.99	11.99	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.01	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.84	11.84	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	11.99	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.99	11.99	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	12.03	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.11	12.11	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.13	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.91	11.91	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	11.94	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.63	11.63	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	11.91	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/23 | Sheet No.: 3 of 5
County: New Castle | Checked by: TMC | Date: 3/23/23 | Cm. No.: 20077
Segment: East Bank Blvd Outfall | Design Freq.: 10 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	**HGL Check**
P-158	DI-158	DI-154	1.00	12.62	12.62	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.63	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.61	12.61	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.62	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.50	12.50	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	12.61	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.34	12.34	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	12.50	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.13	12.13	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	12.34	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.96	11.96	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	12.13	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.79	11.79	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	11.96	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.64	11.64	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	11.79	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.42	11.42	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	11.64	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.23	11.23	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	11.42	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.12	11.12	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	11.23	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.00	11.00	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	11.12	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**11.00**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.23	11.23	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.23	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.23	11.23	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.23	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.12	11.12	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	11.17	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.12	11.12	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	11.17	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.24	11.24	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	11.66	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.00	11.00	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	11.24	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.06	11.06	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	11.14	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.00	11.00	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	11.06	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.13	13.13	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	13.16	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.97	12.97	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	13.13	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.77	12.77	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	12.97	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.56	12.56	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	12.77	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.08	12.08	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	12.56	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.42	11.42	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	12.08	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.74	12.74	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.76	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.66	12.66	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	12.74	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.56	12.56	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	12.66	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.79	11.79	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.79	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.76	11.76	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	11.79	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.71	11.71	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	11.76	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.63	11.63	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	11.71	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.54	11.54	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	11.63	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.63	11.63	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.63	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.71	11.71	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.75	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.72	11.72	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.72	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.69	11.69	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	11.72	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.65	11.65	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	11.69	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.60	11.60	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	11.65	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.54	11.54	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	11.60	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.42	11.42	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	11.54	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.65	11.65	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	11.67	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.05	12.05	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.06	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.98	11.98	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	12.05	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.83	11.83	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	11.98	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.64	11.64	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	11.83	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.05	12.05	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.08	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.57	12.57	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.58	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.51	12.51	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.57	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.49	12.49	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.51	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.34	12.34	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	12.49	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.49	12.49	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	12.53	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.61	12.61	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.63	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.41	12.41	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	12.44	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.13	12.13	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	12.41	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 10 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
			0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	13.32	13.32	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.33	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.31	13.31	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.32	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.20	13.20	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	*0.5*	0.04	0.11	13.31	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.04	13.04	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	13.20	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.83	12.83	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	13.04	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.66	12.66	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	*0.5*	0.09	0.17	12.83	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.49	12.49	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	12.66	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.34	12.34	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	12.49	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.12	12.12	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	*0.5*	0.06	0.22	12.34	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.93	11.93	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	*0.5*	0.14	0.19	12.12	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.82	11.82	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	*0.5*	0.06	0.11	11.93	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.70	11.70	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	*0.5*	0.07	0.12	11.82	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	***0.5***	**0.08**	**0.16**	**11.70**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.93	11.93	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.93	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.93	11.93	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.93	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.82	11.82	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.05	11.87	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.82	11.82	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.04	11.87	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.94	11.94	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	12.36	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.70	11.70	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	*1.3*	1.0	0.21	0.24	11.94	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.76	11.76	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	11.84	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.70	11.70	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	*1.3*	1.0	0.05	0.06	11.76	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.83	13.83	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	13.86	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.67	13.67	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	*0.5*	0.06	0.16	13.83	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.47	13.47	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	13.67	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.26	13.26	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	13.47	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.78	12.78	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	13.26	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.12	12.12	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	12.78	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.44	13.44	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	13.46	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.36	13.36	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	*0.5*	0.03	0.07	13.44	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.26	13.26	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	*1.3*	1.0	0.05	0.11	13.36	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.49	12.49	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.49	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.46	12.46	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	*1.3*	1.0	0.01	0.03	12.49	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.41	12.41	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	*1.3*	1.0	0.02	0.05	12.46	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.33	12.33	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	*0.5*	0.06	0.08	12.41	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.24	12.24	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	12.33	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.33	12.33	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.33	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.41	12.41	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	12.45	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.42	12.42	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.42	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.39	12.39	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	*1.3*	1.0	0.00	0.02	12.42	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.35	12.35	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	*1.3*	1.0	0.02	0.05	12.39	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.30	12.30	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	*0.5*	0.03	0.05	12.35	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.24	12.24	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	12.30	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.12	12.12	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	*0.5*	0.05	0.11	12.24	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.35	12.35	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.02	12.37	10.00	HGL Too High!

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Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.75	12.75	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.76	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.68	12.68	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	12.75	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.53	12.53	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	12.68	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.34	12.34	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	12.53	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.75	12.75	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.78	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.27	13.27	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.28	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.21	13.21	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.27	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.19	13.19	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.21	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.04	13.04	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	13.19	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.19	13.19	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	13.23	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.31	13.31	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	13.33	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.11	13.11	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	13.14	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.83	12.83	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	13.11	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Hi= H_Δ +H_t +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	13.82	13.82	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.83	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.81	13.81	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.82	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.70	13.70	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	13.81	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.54	13.54	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	13.70	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	13.33	13.33	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	13.54	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	13.16	13.16	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	13.33	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.99	12.99	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	13.16	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.84	12.84	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	12.99	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.62	12.62	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	12.84	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.43	12.43	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	12.62	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	12.32	12.32	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	12.43	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	12.20	12.20	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	12.32	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**12.20**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.43	12.43	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.43	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.43	12.43	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.43	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	12.32	12.32	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	12.37	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	12.32	12.32	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	12.37	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.44	12.44	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	12.86	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	12.20	12.20	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	12.44	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	12.26	12.26	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	12.34	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	12.20	12.20	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	12.26	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.33	14.33	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	14.36	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.17	14.17	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	14.33	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.97	13.97	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	14.17	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.76	13.76	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	13.97	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.28	13.28	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	13.76	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.62	12.62	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	13.28	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.94	13.94	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	13.96	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.86	13.86	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	13.94	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.76	13.76	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	13.86	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.99	12.99	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.99	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.96	12.96	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	12.99	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.91	12.91	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	12.96	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.83	12.83	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	12.91	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.74	12.74	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	12.83	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.83	12.83	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.83	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.91	12.91	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	12.95	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.92	12.92	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.92	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.89	12.89	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	12.92	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.85	12.85	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	12.89	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.80	12.80	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	12.85	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.74	12.74	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	12.80	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.62	12.62	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	12.74	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.85	12.85	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.87	10.00	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	13.25	13.25	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.26	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.18	13.18	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	13.25	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	13.03	13.03	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	13.18	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.84	12.84	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	13.03	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	13.25	13.25	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	13.28	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.77	13.77	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.78	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.71	13.71	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.77	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.69	13.69	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.71	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.54	13.54	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	13.69	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.69	13.69	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	13.73	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.81	13.81	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	13.83	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.61	13.61	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	13.64	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.33	13.33	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	13.61	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle Δ_o	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Hi= H_Δ +H_t +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	15.12	15.12	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.13	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	15.11	15.11	15	1.0	0.8	10	24	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.12	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	15.00	15.00	18	4.2	2.4	89	51	0.0013	0.07	0	0.00	0.02	0.8	6.2	0.0	1.9	0.0	89	0.04	0.08	1.0	0.5	0.04	0.11	15.11	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	14.84	14.84	18	4.5	2.5	94	33	0.0016	0.05	0	0.00	0.02	9.8	0.0	0.0	2.4	0.0	89	0.06	0.12	1.0	1.0	0.12	0.17	15.00	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	14.63	14.63	30	14.4	2.9	85	97	0.0010	0.10	0	0.00	0.03	11.4	30.7	0.0	3.1	0.1	3	0.02	0.10	1.0	1.0	0.10	0.20	14.84	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	14.46	14.46	36	21.4	3.0	2	97	0.0009	0.09	0	0.00	0.04	42.1	32.7	0.0	2.9	0.0	85	0.09	0.17	1.0	0.5	0.09	0.17	14.63	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	14.29	14.29	36	21.6	3.0	1	96	0.0009	0.09	0	0.00	0.04	65.0	0.0	0.0	3.0	0.0	2	0.00	0.09	1.0	1.0	0.09	0.17	14.46	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	14.14	14.14	36	21.8	3.1	5	68	0.0009	0.06	0	0.00	0.04	65.7	0.0	0.0	3.0	0.1	1	0.00	0.09	1.0	1.0	0.09	0.15	14.29	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	13.92	13.92	36	26.8	3.8	86	115	0.0014	0.16	0	0.00	0.06	67.4	12.4	0.0	3.1	0.1	5	0.01	0.12	1.0	0.5	0.06	0.22	14.14	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	13.73	13.73	48	46.2	3.7	0	55	0.0009	0.05	0	0.00	0.05	101.3	46.5	28.7	3.8	0.1	86	0.15	0.28	1.0	0.5	0.14	0.19	13.92	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	13.62	13.62	48	46.9	3.7	0	50	0.0009	0.05	0	0.00	0.05	169.6	0.1	0.2	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	13.73	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	13.50	13.50	48	52.1	4.1	0	44	0.0011	0.05	0	0.00	0.07	175.1	5.3	4.9	3.7	0.1	0	0.00	0.14	1.0	0.5	0.07	0.12	13.62	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**55.0**	**4.4**	**0**	**64**	**0.0012**	**0.08**	**0**	**0.00**	**0.07**	**215.6**	**3.5**	**1.7**	**4.1**	**0.1**	**0**	**0.00**	**0.17**	**1.0**	**0.5**	**0.08**	**0.16**	**13.50**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	13.73	13.73	18	0.5	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.73	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	13.73	13.73	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.73	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	13.62	13.62	18	3.1	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	13.67	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	13.62	13.62	18	2.9	1.7	90	55	0.0007	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	13.67	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	13.74	13.74	8	1.2	3.3	56	56	0.0067	0.37	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.42	14.16	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	13.50	13.50	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	3.9	0.0	0.0	3.3	0.1	56	0.09	0.16	1.3	1.0	0.21	0.24	13.74	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	13.56	13.56	8	0.5	1.6	45	45	0.0015	0.07	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	13.64	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	13.50	13.50	15	1.5	1.2	90	30	0.0004	0.01	0	0.00	0.01	0.9	0.0	0.0	1.6	0.0	45	0.02	0.04	1.3	1.0	0.05	0.06	13.56	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	15.63	15.63	18	4.5	2.5	86	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	15.66	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	15.47	15.47	18	4.5	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.4	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.16	15.63	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	15.27	15.27	18	4.8	2.7	89	71	0.0018	0.13	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	4	0.01	0.07	1.0	1.0	0.07	0.20	15.47	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	15.06	15.06	18	5.2	2.9	72	27	0.0021	0.06	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.21	15.27	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	14.58	14.58	18	8.9	5.0	25	41	0.0061	0.25	0	0.00	0.10	15.1	6.6	0.0	2.9	0.0	72	0.08	0.23	1.0	1.0	0.23	0.48	15.06	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	13.92	13.92	18	9.1	5.1	97	47	0.0063	0.30	0	0.00	0.10	44.8	0.0	0.0	5.0	0.1	25	0.12	0.36	1.0	1.0	0.36	0.66	14.58	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	15.24	15.24	18	3.1	1.7	86	17	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	15.26	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	15.16	15.16	18	3.0	1.7	4	60	0.0007	0.04	0	0.00	0.01	5.3	0.0	0.0	1.7	0.0	86	0.03	0.06	1.0	0.5	0.03	0.07	15.24	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	15.06	15.06	18	3.4	1.9	19	71	0.0009	0.06	0	0.00	0.01	5.2	0.0	0.0	1.7	0.0	4	0.00	0.04	1.3	1.0	0.05	0.11	15.16	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	14.29	14.29	15	0.4	0.3	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.29	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	14.26	14.26	15	1.1	0.9	7	84	0.0003	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	2	0.00	0.00	1.3	1.0	0.01	0.03	14.29	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	14.21	14.21	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.1	0.0	0.0	0.9	0.0	7	0.00	0.01	1.3	1.0	0.02	0.05	14.26	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	14.13	14.13	24	6.0	1.9	81	36	0.0006	0.02	0	0.00	0.01	2.4	11.3	0.0	2.5	0.0	81	0.07	0.11	1.0	0.5	0.06	0.08	14.21	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	14.04	14.04	24	6.6	2.1	90	31	0.0007	0.02	0	0.00	0.02	11.4	0.0	0.0	1.9	0.0	81	0.04	0.07	1.0	1.0	0.07	0.10	14.13	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	14.13	14.13	15	0.2	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.13	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	14.21	14.21	18	4.5	2.5	81	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	14.25	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	14.22	14.22	15	0.4	0.3	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.22	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	14.19	14.19	15	1.1	0.9	5	83	0.0002	0.02	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	6	0.00	0.00	1.3	1.0	0.00	0.02	14.22	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	14.15	14.15	15	1.7	1.4	14	56	0.0006	0.03	0	0.00	0.01	1.0	0.0	0.0	0.9	0.0	5	0.00	0.01	1.3	1.0	0.02	0.05	14.19	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	14.10	14.10	24	4.8	1.5	81	36	0.0004	0.01	0	0.00	0.01	2.3	6.2	0.0	1.9	0.0	81	0.04	0.06	1.0	0.5	0.03	0.05	14.15	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	14.04	14.04	24	5.3	1.7	90	31	0.0005	0.01	0	0.00	0.01	7.4	0.0	0.0	1.5	0.0	81	0.02	0.05	1.0	1.0	0.05	0.06	14.10	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	13.92	13.92	30	11.9	2.4	0	94	0.0007	0.07	0	0.00	0.02	9.0	13.8	0.0	2.1	0.0	90	0.05	0.09	1.0	0.5	0.05	0.11	14.04	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	14.15	14.15	18	3.3	1.9	81	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	14.17	10.00	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	14.55	14.55	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.56	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	14.48	14.48	18	3.6	2.0	7	39	0.0010	0.04	0	0.00	0.02	0.1	6.2	0.0	1.9	0.0	83	0.04	0.07	1.0	0.5	0.04	0.07	14.55	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	14.33	14.33	18	4.0	2.3	89	68	0.0013	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	7	0.01	0.05	1.3	1.0	0.06	0.15	14.48	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	14.14	14.14	18	4.7	2.6	86	25	0.0017	0.04	0	0.00	0.03	9.3	0.0	0.0	2.3	0.0	89	0.06	0.11	1.3	1.0	0.15	0.19	14.33	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	14.55	14.55	18	3.3	1.9	83	17	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	14.58	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	15.07	15.07	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.08	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	15.01	15.01	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	15.07	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	14.99	14.99	15	1.6	1.3	10	24	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	15.01	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	14.84	14.84	24	9.8	3.1	3	51	0.0016	0.08	0	0.00	0.04	2.0	21.9	0.0	2.6	0.0	89	0.08	0.15	1.0	0.5	0.08	0.16	14.99	10.06	HGL Too High!
P-153	B1	MH-151	1.60	14.99	14.99	24	8.3	2.6	89	17	0.0011	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	15.03	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	15.11	15.11	18	3.3	1.9	89	18	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	15.13	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	14.91	14.91	18	2.9	1.6	90	50	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	14.94	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	14.63	14.63	18	7.6	4.3	92	44	0.0045	0.20	0	0.00	0.07	4.8	0.0	4.8	1.6	0.0	90	0.03	0.12	1.3	0.5	0.08	0.27	14.91	10.50	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 25	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-158	DI-158	DI-154	3887	225	4112	0.09	0.91	0.09	0.09	6.0	0.00	4.01	**0.34**	15	100	0.012	0.000024	0.0053	4.2	**5.1**	2.0	0.82	6.82	**4.36**	3.83	Q ok
P-154	DI-154	MH-155	3023	31	3054	0.07	1.00	0.07	0.16	6.0	6.82	6.61	**1.03**	15	24	0.012	0.000216	0.0042	3.7	**4.5**	3.0	0.13	6.95	**3.73**	3.63	Q ok
P-155	MH-155	DI-156	1	0	1	0.00	1.00	0.00	0.72	6.0	6.95	6.55	**4.72**	18	51	0.012	0.001717	0.0039	4.0	**7.1**	4.3	0.20	7.15	3.53	3.33	Q ok
P-156	DI-156	DI-152	2725	0	2725	0.06	1.00	0.06	0.78	6.0	7.15	6.52	**5.10**	18	33	0.012	0.002010	0.0039	4.0	**7.1**	4.4	0.12	7.27	3.23	3.10	Q ok
P-152	DI-152	MH-140	3517	0	3517	0.08	1.00	0.08	2.52	6.0	7.27	6.46	**16.29**	**30**	97	0.012	0.001344	0.0040	5.7	**28.2**	6.0	0.27	7.54	3.00	2.61	Q ok
P-140	MH-140	DI-141	1	0	1	0.00	1.00	0.00	3.79	6.0	7.54	6.41	**24.27**	36	97	0.012	0.001129	0.0040	6.5	**45.8**	6.6	0.24	7.79	2.51	2.12	Q ok
P-141	DI-141	DI-142	3263	65	3328	0.08	1.00	0.08	3.87	6.0	7.79	6.32	**24.43**	36	96	0.012	0.001143	0.0040	6.4	**45.5**	6.6	0.24	8.03	2.02	1.64	Q ok
P-142	DI-142	DI-143	3699	195	3894	0.09	1.00	0.09	3.96	6.0	8.03	6.26	**24.76**	36	68	0.012	0.001175	0.0040	6.4	**45.5**	6.6	0.17	8.20	1.54	1.27	Q ok
P-143	DI-143	MH-170	5428	266	5694	0.13	1.00	0.13	4.93	6.0	8.20	6.20	**30.55**	36	115	0.012	0.001788	0.0040	6.5	**45.7**	6.9	0.28	8.48	1.17	0.71	Q ok
P-170	MH-170	MH-171	1	0	1	0.00	1.00	0.00	8.71	6.0	8.48	6.12	**53.28**	48	55	0.012	0.001172	0.0040	7.8	**98.4**	8.0	0.11	8.59	0.61	0.39	Q ok
P-171	MH-171	MH-172	1	0	1	0.00	1.00	0.00	8.90	6.0	8.59	6.09	**54.18**	48	50	0.012	0.001212	0.0040	7.8	**98.4**	8.0	0.10	8.70	0.29	0.09	Q ok
P-172	MH-172	MH-173	1	0	1	0.00	1.00	0.00	9.93	6.0	8.70	6.06	**60.12**	48	44	0.012	0.001493	0.0041	7.9	**99.5**	8.3	0.09	8.79	-0.01	-0.19	Q ok
P-173	MH-173	OUTFALL	1	0	1	0.00	1.00	0.00	10.55	6.0	8.79	6.03	**63.57**	**48**	64	0.012	0.001669	0.0041	7.9	**99.2**	8.4	0.13	8.91	-0.29	**-0.55**	Q ok
P-174	DI-174	MH-171	3578	530	4108	0.09	0.94	0.09	0.09	6.0	0.00	6.84	**0.60**	18	33	0.012	0.000028	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-175	DI-175	MH-171	4118	530	4648	0.11	0.95	0.10	0.10	6.0	0.00	6.84	**0.69**	18	33	0.012	0.000037	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-176	B4 North	MH-172	22780	0	22780	0.52	1.00	0.52	0.52	6.0	0.00	6.84	**3.58**	18	55	0.012	0.000988	0.0049	4.5	**8.0**	4.4	0.21	6.21	1.26	0.99	Q ok
P-177	B2 South	MH-172	21809	0	21809	0.50	1.00	0.50	0.50	6.0	0.00	6.84	**3.42**	18	55	0.012	0.000906	0.0049	4.5	**8.0**	4.4	0.21	6.21	1.26	0.99	Q ok
P-178	TD-03	DI-179	8687	0	8687	0.20	1.00	0.20	0.20	6.0	0.00	6.84	**1.36**	8	56	0.011	0.009123	0.0509	9.2	**3.2**	8.5	0.11	6.11	8.55	5.70	Q ok
P-179	DI-179	MH-173	6306	3055	9361	0.21	0.77	0.17	0.36	6.0	6.11	6.81	**2.48**	15	30	0.012	0.001259	0.0500	12.8	**15.6**	8.9	0.06	6.17	3.21	1.71	Q ok
P-180	TD-02	DI-181	4084	0	4084	0.09	1.00	0.09	0.09	6.0	0.00	6.84	**0.64**	8	45	0.011	0.002016	0.0500	9.1	**3.2**	6.9	0.11	6.11	8.50	6.25	Q ok
P-181	DI-181	MH-173	6222	2906	9128	0.21	0.78	0.16	0.26	6.0	6.11	6.81	**1.75**	15	30	0.012	0.000622	0.0500	12.8	**15.6**	7.7	0.07	6.17	3.21	1.71	Q ok
P-115	B5 West	MH-116	33468	0	33468	0.77	1.00	0.77	0.77	6.0	0.00	6.84	**5.26**	18	17	0.012	0.002133	0.0047	4.4	**7.8**	4.7	0.06	6.06	3.84	3.76	Q ok
P-116	MH-116	DI-117	1	0	1	0.00	1.00	0.00	0.77	6.0	6.06	6.81	**5.23**	18	60	0.012	0.002115	0.0050	4.6	**8.0**	4.9	0.21	6.27	3.66	3.36	Q ok
P-117	DI-117	DI-118	2919	167	3086	0.07	1.00	0.07	0.84	6.0	6.27	6.75	**5.67**	18	71	0.012	0.002480	0.0051	4.6	**8.1**	5.0	0.24	6.50	3.26	2.90	Q ok
P-118	DI-118	DI-113	2866	196	3062	0.07	0.99	0.07	0.91	6.0	6.50	6.70	**6.08**	18	27	0.012	0.002859	0.0048	4.5	**7.9**	5.0	0.09	6.59	2.80	2.67	Q ok
P-113	DI-113	DI-114	2882	195	3077	0.07	0.99	0.07	1.57	6.0	6.59	6.67	**10.47**	18	41	0.012	0.008467	0.0200	9.1	**16.1**	9.7	0.07	6.66	2.57	1.75	Q ok
P-114	DI-114	MH-170	1592	20	1612	0.04	1.00	0.04	1.61	6.0	6.66	6.64	**10.67**	18	47	0.012	0.008794	0.0200	9.1	**16.1**	9.7	0.08	6.74	1.65	0.71	Q ok
P-110	B4 South	MH-111	22751	0	22751	0.52	1.00	0.52	0.52	6.0	0.00	6.84	**3.57**	18	17	0.012	0.000986	0.0053	4.7	**8.3**	4.5	0.06	6.06	3.61	3.52	Q ok
P-111	MH-111	DI-112	1	0	1	0.00	1.00	0.00	0.52	6.0	6.06	6.81	**3.56**	18	60	0.012	0.000977	0.0050	4.6	**8.0**	4.4	0.23	6.29	3.42	3.12	Q ok
P-112	DI-112	DI-113	2877	164	3041	0.07	1.00	0.07	0.59	6.0	6.29	6.75	**4.00**	18	71	0.012	0.001234	0.0049	4.5	**8.0**	4.5	0.26	6.55	3.02	2.67	Q ok
P-120	DI-120	DI-121	2879	334	3213	0.07	0.96	0.07	0.07	6.0	0.00	6.84	**0.48**	15	22	0.012	0.000048	0.0032	3.2	**3.9**	1.9	0.19	6.19	**3.96**	3.89	Q ok
P-121	DI-121	DI-122	5403	1316	6719	0.15	0.88	0.14	0.21	6.0	6.19	6.78	**1.40**	15	84	0.012	0.000399	0.0031	3.2	**3.9**	2.9	0.49	6.68	3.79	3.53	Q ok
P-122	DI-122	MH-123	4404	1304	5708	0.13	0.85	0.11	0.32	6.0	6.68	6.64	**2.11**	15	56	0.012	0.000908	0.0030	3.1	**3.9**	3.2	0.29	6.97	3.43	3.26	Q ok
P-123	MH-123	DI-124	1	0	1	0.00	1.00	0.00	1.08	6.0	6.97	6.55	**7.09**	**24**	36	0.012	0.000836	0.0036	4.7	**14.7**	4.6	0.13	7.10	3.16	3.03	Q ok
P-124	DI-124	MH-135	3437	323	3760	0.09	0.97	0.08	1.20	6.0	7.10	6.52	**7.84**	**24**	31	0.012	0.001024	0.0048	5.4	**17.0**	5.3	0.10	7.20	2.93	2.78	Q ok
P-125	DI-125	DI-124	1587	15	1602	0.04	1.00	0.04	0.04	6.0	0.00	6.84	**0.25**	15	45	0.012	0.000013	0.0040	3.6	**4.4**	1.8	0.42	6.42	3.21	3.03	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 25	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-126	B5 North	MH-123	33276	0	33276	0.76	1.00	0.76	0.76	6.0	0.00	6.84	**5.23**	18	17	0.012	0.002108	0.0053	4.7	**8.3**	5.0	0.06	6.06	3.36	3.27	Q ok
P-130	DI-130	DI-131	2606	339	2945	0.07	0.95	0.06	0.06	6.0	0.00	6.84	**0.44**	15	22	0.012	0.000039	0.0032	3.2	**3.9**	1.9	0.19	6.19	**3.96**	3.89	Q ok
P-131	DI-131	DI-132	5203	1533	6736	0.15	0.85	0.13	0.20	6.0	6.19	6.78	**1.33**	15	83	0.012	0.000360	0.0030	3.1	**3.8**	2.8	0.49	6.68	3.79	3.54	Q ok
P-132	DI-132	MH-133	4517	1246	5763	0.13	0.86	0.11	0.31	6.0	6.68	6.64	**2.06**	15	56	0.012	0.000864	0.0030	3.1	**3.9**	3.2	0.29	6.97	3.44	3.27	Q ok
P-133	MH-133	DI-134	1	0	1	0.00	1.00	0.00	0.87	6.0	6.97	6.55	**5.72**	24	36	0.012	0.000546	0.0031	4.3	**13.5**	4.0	0.15	7.12	3.17	3.06	Q ok
P-134	DI-134	MH-135	4193	284	4477	0.10	0.99	0.10	0.98	6.0	7.12	6.52	**6.36**	**24**	31	0.012	0.000674	0.0035	4.6	**14.6**	4.5	0.11	7.24	2.96	2.85	Q ok
P-135	MH-135	MH-170	1	0	1	0.00	1.00	0.00	2.18	6.0	7.24	6.49	**14.14**	**30**	94	0.012	0.001013	0.0039	5.7	**27.9**	5.6	0.28	7.52	2.67	2.30	Q ok
P-136	B3 South	MH-133	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	6.84	**3.86**	18	17	0.012	0.001149	0.0047	4.4	**7.8**	4.4	0.06	6.06	3.36	3.28	Q ok
P-144	DI-144	MH-145	2618	65	2683	0.06	1.00	0.06	0.06	6.0	0.00	6.84	**0.42**	15	55	0.012	0.000036	0.0051	4.1	**5.0**	2.4	0.38	6.38	3.79	3.51	Q ok
P-145	MH-145	DI-146	1	0	1	0.00	1.00	0.00	0.63	6.0	6.38	6.72	**4.21**	18	39	0.012	0.001367	0.0049	4.5	**7.9**	4.6	0.14	6.52	3.41	3.22	Q ok
P-146	DI-146	DI-147	3675	195	3870	0.09	1.00	0.09	0.71	6.0	6.52	6.70	**4.78**	18	68	0.012	0.001767	0.0050	4.6	**8.0**	4.8	0.24	6.75	3.12	2.78	Q ok
P-147	DI-147	DI-143	5191	266	5457	0.13	1.00	0.13	0.84	6.0	6.75	6.61	**5.55**	18	25	0.012	0.002378	0.0052	4.6	**8.2**	5.1	0.08	6.84	2.68	2.55	Q ok
P-148	B3 West	MH-145	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	6.84	**3.86**	18	17	0.012	0.001149	0.0053	4.7	**8.3**	4.5	0.06	6.06	3.60	3.51	Q ok
P-167	DI-167	DI-159	3909	227	4136	0.09	0.91	0.09	0.09	6.0	6.00	4.01	**0.35**	15	18	0.012	0.000024	0.0033	3.3	**4.0**	2.0	0.15	6.15	4.29	4.23	Q ok
P-159	DI-159	DI-150	3909	227	4136	0.09	0.91	0.09	0.17	6.0	6.15	3.98	**0.69**	15	100	0.012	0.000096	0.0053	4.2	**5.1**	2.9	0.57	6.73	4.13	3.60	Q ok
P-150	DI-150	MH-151	3037	0	3037	0.07	1.00	0.07	0.24	6.0	0.00	6.84	**1.66**	15	24	0.012	0.000560	0.0042	3.7	**4.5**	3.3	0.12	6.12	3.50	3.40	Q ok
P-151	MH-151	DI-152	1	0	1	0.00	1.00	0.00	1.66	6.0	6.12	6.81	**11.29**	24	51	0.012	0.002123	0.0039	4.9	**15.3**	5.4	0.16	6.28	3.30	3.10	Q ok
P-153	B1	MH-151	61668	0	61668	1.42	1.00	1.42	1.42	6.0	0.00	6.84	**9.68**	24	17	0.012	0.001561	0.0100	7.8	**24.5**	7.2	0.04	6.04	3.57	3.40	Q ok
P-157	B3 North	MH-155	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	6.84	**3.86**	18	18	0.012	0.001149	0.0050	4.6	**8.0**	4.5	0.07	6.07	3.72	3.63	Q ok
P-166	B2 North	MH-163	21657	0	21657	0.50	1.00	0.50	0.50	6.0	0.00	6.84	**3.40**	18	50	0.012	0.000893	0.0050	4.6	**8.0**	4.2	0.20	6.20	3.62	3.37	Q ok
P-163	MH-163	MH-140	1	0	1	0.00	1.00	0.00	1.27	6.0	6.20	6.78	**8.61**	18	44	0.012	0.005720	0.0150	7.9	**13.9**	8.3	0.09	6.29	3.27	2.61	Q ok

KEY	
	Upsized from Semi-Final Design to have capacity for 50-yr design storm
	Optional Upsize-50-yr design storm results in >85% Full
	No Change from Semi-Final Design

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t= H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\ adj}$ ft	Tot. H Loss, $H = H_f + H_{t\ adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	5.60	5.60	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.62	7.70	HGL ok
P-154	DI-154	MH-155	1.00	5.59	5.59	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.60	9.06	HGL ok
P-155	MH-155	DI-156	1.20	5.45	5.45	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	0.5	0.05	0.15	5.59	10.06	HGL ok
P-156	DI-156	DI-152	1.20	5.22	5.22	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	5.45	11.07	HGL ok
P-152	DI-152	MH-140	2.00	4.95	4.95	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	5.22	11.07	HGL ok
P-140	MH-140	DI-141	2.40	4.72	4.72	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	0.5	0.12	0.23	4.95	12.04	HGL ok
P-141	DI-141	DI-142	2.40	4.49	4.49	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	4.72	11.02	HGL ok
P-142	DI-142	DI-143	2.40	4.29	4.29	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	4.49	10.52	HGL ok
P-143	DI-143	MH-170	2.40	4.00	4.00	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	0.5	0.08	0.29	4.29	10.28	HGL ok
P-170	MH-170	MH-171	3.20	3.74	3.74	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	0.5	0.19	0.26	4.00	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.59	3.59	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	3.74	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.43	3.43	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	3.59	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.20**	**3.20**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	**0.5**	**0.12**	**0.23**	**3.43**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	3.74	3.74	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.74	10.61	HGL ok
P-175	DI-175	MH-171	1.20	3.74	3.74	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.74	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.59	3.59	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	3.65	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.59	3.59	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.06	3.65	10.00	HGL ok
P-178	TD-03	DI-179	0.53	3.76	6.23	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	6.80	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.43	3.43	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	1.3	1.0	0.29	0.33	3.76	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.51	6.78	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	6.89	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.43	3.43	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	1.3	1.0	0.07	0.08	3.51	9.25	HGL ok
P-115	B5 West	MH-116	1.20	6.35	6.35	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	6.41	10.00	HGL ok
P-116	MH-116	DI-117	1.20	6.14	6.14	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	0.5	0.09	0.21	6.35	11.99	HGL ok
P-117	DI-117	DI-118	1.20	5.86	5.86	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	6.14	11.71	HGL ok
P-118	DI-118	DI-113	1.20	5.57	5.57	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	5.86	11.30	HGL ok
P-113	DI-113	DI-114	1.20	4.91	4.91	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	5.57	11.30	HGL ok
P-114	DI-114	MH-170	1.20	4.00	4.00	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	4.91	10.75	HGL ok
P-110	B4 South	MH-111	1.20	5.82	5.82	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	5.84	10.00	HGL ok
P-111	MH-111	DI-112	1.20	5.72	5.72	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.10	5.82	11.99	HGL ok
P-112	DI-112	DI-113	1.20	5.57	5.57	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	1.3	1.0	0.06	0.15	5.72	11.71	HGL ok
P-120	DI-120	DI-121	1.00	4.86	4.89	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-121	DI-121	DI-122	1.00	4.82	4.82	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.04	4.86	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.74	4.74	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	1.3	1.0	0.03	0.08	4.82	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.60	4.63	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	0.5	0.08	0.11	4.74	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.46	4.46	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	4.60	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.60	4.60	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.60	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.74	4.74	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	4.79	10.00	HGL ok
P-130	DI-130	DI-131	1.00	4.83	4.89	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.80	4.80	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.04	4.83	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.72	4.72	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	1.3	1.0	0.02	0.07	4.80	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.57	4.66	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	0.5	0.04	0.06	4.72	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.46	4.46	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	1.3	1.0	0.09	0.11	4.57	9.44	HGL ok
P-135	MH-135	MH-170	2.00	4.00	4.30	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	0.5	0.07	0.16	4.46	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.72	4.72	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	4.75	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	4.87	4.87	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.87	11.02	HGL ok
P-145	MH-145	DI-146	1.20	4.77	4.77	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	4.87	10.87	HGL ok
P-146	DI-146	DI-147	1.20	4.56	4.56	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	4.77	10.52	HGL ok
P-147	DI-147	DI-143	1.20	4.29	4.29	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	4.56	10.28	HGL ok
P-148	B3 West	MH-145	1.20	4.87	4.87	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	4.90	10.00	HGL ok
P-167	DI-167	DI-159	1.00	5.52	5.52	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.52	7.48	HGL ok
P-159	DI-159	DI-150	1.00	5.46	5.46	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	5.52	7.70	HGL ok
P-150	DI-150	MH-151	1.00	5.44	5.44	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	5.46	9.06	HGL ok
P-151	MH-151	DI-152	1.60	5.22	5.22	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	5.44	10.06	HGL ok
P-153	B1	MH-151	1.60	5.44	5.44	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	5.48	10.00	HGL ok
P-157	B3 North	MH-155	1.20	5.59	5.59	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	5.62	10.00	HGL ok
P-166	B2 North	MH-163	1.20	5.30	5.30	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	5.35	10.00	HGL ok
P-163	MH-163	MH-140	1.20	4.95	4.95	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	5.30	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\ adj}$ ft	Tot. H Loss, $H = H_f + H_{t\ adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	5.80	5.80	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.82	7.70	HGL ok
P-154	DI-154	MH-155	1.00	5.79	5.79	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.80	9.06	HGL ok
P-155	MH-155	DI-156	1.20	5.65	5.65	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	*0.5*	0.05	0.15	5.79	10.06	HGL ok
P-156	DI-156	DI-152	1.20	5.42	5.42	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	5.65	11.07	HGL ok
P-152	DI-152	MH-140	2.00	5.15	5.15	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	5.42	11.07	HGL ok
P-140	MH-140	DI-141	2.40	4.92	4.92	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	*0.5*	0.12	0.23	5.15	12.04	HGL ok
P-141	DI-141	DI-142	2.40	4.69	4.69	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	4.92	11.02	HGL ok
P-142	DI-142	DI-143	2.40	4.49	4.49	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	4.69	10.52	HGL ok
P-143	DI-143	MH-170	2.40	4.20	4.20	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	*0.5*	0.08	0.29	4.49	10.28	HGL ok
P-170	MH-170	MH-171	3.20	3.94	3.94	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	*0.5*	0.19	0.26	4.20	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.79	3.79	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	*0.5*	0.09	0.15	3.94	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.63	3.63	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	*0.5*	0.10	0.17	3.79	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.40**	**3.40**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	***0.5***	**0.12**	**0.23**	**3.63**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	3.94	3.94	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.94	10.61	HGL ok
P-175	DI-175	MH-171	1.20	3.94	3.94	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.94	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.79	3.79	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.06	3.85	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.79	3.79	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.06	3.85	10.00	HGL ok
P-178	TD-03	DI-179	0.53	3.96	6.23	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	6.80	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.63	3.63	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	*1.3*	1.0	0.29	0.33	3.96	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.71	6.78	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	6.89	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.63	3.63	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	*1.3*	1.0	0.07	0.08	3.71	9.25	HGL ok
P-115	B5 West	MH-116	1.20	6.55	6.55	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.02	0.05	6.61	10.00	HGL ok
P-116	MH-116	DI-117	1.20	6.34	6.34	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	*0.5*	0.09	0.21	6.55	11.99	HGL ok
P-117	DI-117	DI-118	1.20	6.06	6.06	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	6.34	11.71	HGL ok
P-118	DI-118	DI-113	1.20	5.77	5.77	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	6.06	11.30	HGL ok
P-113	DI-113	DI-114	1.20	5.11	5.11	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	5.77	11.30	HGL ok
P-114	DI-114	MH-170	1.20	4.20	4.20	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	5.11	10.75	HGL ok
P-110	B4 South	MH-111	1.20	6.02	6.02	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.02	6.04	10.00	HGL ok
P-111	MH-111	DI-112	1.20	5.92	5.92	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	*0.5*	0.04	0.10	6.02	11.99	HGL ok
P-112	DI-112	DI-113	1.20	5.77	5.77	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	*1.3*	1.0	0.06	0.15	5.92	11.71	HGL ok
P-120	DI-120	DI-121	1.00	4.86	4.89	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-121	DI-121	DI-122	1.00	4.82	4.82	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.04	4.86	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.74	4.74	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	*1.3*	1.0	0.03	0.08	4.82	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.60	4.63	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	*0.5*	0.08	0.11	4.74	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.46	4.46	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	4.60	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.60	4.60	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.60	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.74	4.74	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.02	0.05	4.79	10.00	HGL ok
P-130	DI-130	DI-131	1.00	4.83	4.89	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.80	4.80	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.04	4.83	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.72	4.72	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	*1.3*	1.0	0.02	0.07	4.80	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.57	4.66	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	*0.5*	0.04	0.06	4.72	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.46	4.46	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	*1.3*	1.0	0.09	0.11	4.57	9.44	HGL ok
P-135	MH-135	MH-170	2.00	4.20	4.30	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	*0.5*	0.07	0.16	4.46	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.72	4.72	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	4.75	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	5.07	5.07	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.07	11.02	HGL ok
P-145	MH-145	DI-146	1.20	4.97	4.97	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	5.07	10.87	HGL ok
P-146	DI-146	DI-147	1.20	4.76	4.76	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	4.97	10.52	HGL ok
P-147	DI-147	DI-143	1.20	4.49	4.49	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	4.76	10.28	HGL ok
P-148	B3 West	MH-145	1.20	5.07	5.07	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	5.10	10.00	HGL ok
P-167	DI-167	DI-159	1.00	5.72	5.72	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.72	7.48	HGL ok
P-159	DI-159	DI-150	1.00	5.66	5.66	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	5.72	7.70	HGL ok
P-150	DI-150	MH-151	1.00	5.64	5.64	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	5.66	9.06	HGL ok
P-151	MH-151	DI-152	1.60	5.42	5.42	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	5.64	10.06	HGL ok
P-153	B1	MH-151	1.60	5.64	5.64	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	5.68	10.00	HGL ok
P-157	B3 North	MH-155	1.20	5.79	5.79	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	5.82	10.00	HGL ok
P-166	B2 North	MH-163	1.20	5.50	5.50	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	5.55	10.00	HGL ok
P-163	MH-163	MH-140	1.20	5.15	5.15	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	5.50	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Hi= H_Δ +H_t +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	9.30	9.30	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.32	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.29	9.29	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.30	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.15	9.15	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	0.5	0.05	0.15	9.29	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	8.92	8.92	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	9.15	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.65	8.65	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	8.92	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.42	8.42	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	0.5	0.12	0.23	8.65	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.19	8.19	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	8.42	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.99	7.99	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	8.19	10.52	HGL ok
P-143	DI-143	MH-170	2.40	7.70	7.70	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	0.5	0.08	0.29	7.99	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.44	7.44	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	0.5	0.19	0.26	7.70	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.29	7.29	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	7.44	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.13	7.13	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	7.29	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	**0.5**	**0.12**	**0.23**	**7.13**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.44	7.44	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.44	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.44	7.44	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.44	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.29	7.29	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	7.35	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.29	7.29	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.06	7.35	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.46	7.46	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	8.03	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.13	7.13	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	1.3	1.0	0.29	0.33	7.46	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.21	7.21	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	7.31	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.13	7.13	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	1.3	1.0	0.07	0.08	7.21	9.25	HGL ok
P-115	B5 West	MH-116	1.20	10.05	10.05	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	10.11	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.84	9.84	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	0.5	0.09	0.21	10.05	11.99	HGL ok
P-117	DI-117	DI-118	1.20	9.56	9.56	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	9.84	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.27	9.27	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	9.56	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.61	8.61	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	9.27	11.30	HGL ok
P-114	DI-114	MH-170	1.20	7.70	7.70	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	8.61	10.75	HGL ok
P-110	B4 South	MH-111	1.20	9.52	9.52	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	9.54	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.42	9.42	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.10	9.52	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.27	9.27	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	1.3	1.0	0.06	0.15	9.42	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.22	8.22	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.23	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.18	8.18	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.04	8.22	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.11	8.11	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	1.3	1.0	0.03	0.08	8.18	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.00	8.00	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	0.5	0.08	0.11	8.11	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	7.86	7.86	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	8.00	9.44	HGL ok
P-125	DI-125	DI-124	1.00	8.00	8.00	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.00	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.11	8.11	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	8.16	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.14	8.14	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.15	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.11	8.11	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.04	8.14	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.03	8.03	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	1.3	1.0	0.02	0.07	8.11	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.97	7.97	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	0.5	0.04	0.06	8.03	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	7.86	7.86	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	1.3	1.0	0.09	0.11	7.97	9.44	HGL ok
P-135	MH-135	MH-170	2.00	7.70	7.70	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	0.5	0.07	0.16	7.86	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.03	8.03	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.06	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.57	8.57	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.57	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.47	8.47	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	8.57	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.26	8.26	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	8.47	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.99	7.99	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	8.26	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.57	8.57	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.60	10.00	HGL ok
P-167	DI-167	DI-159	1.00	9.22	9.22	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.22	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.16	9.16	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	9.22	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.14	9.14	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.16	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.92	8.92	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	9.14	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.14	9.14	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	9.18	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	9.29	9.29	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.32	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.00	9.00	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	9.05	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	8.65	8.65	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	9.00	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 25 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	9.80	9.80	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.82	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.79	9.79	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.80	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.65	9.65	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	0.5	0.05	0.15	9.79	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	9.42	9.42	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	9.65	11.07	HGL ok
P-152	DI-152	MH-140	2.00	9.15	9.15	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	9.42	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.92	8.92	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	0.5	0.12	0.23	9.15	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.69	8.69	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	8.92	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.49	8.49	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	8.69	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.20	8.20	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	0.5	0.08	0.29	8.49	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.94	7.94	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	0.5	0.19	0.26	8.20	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.79	7.79	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	7.94	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.63	7.63	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	7.79	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	**0.5**	**0.12**	**0.23**	**7.63**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.94	7.94	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.94	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.94	7.94	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.94	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.79	7.79	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	7.85	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.79	7.79	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.06	7.85	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.96	7.96	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	8.53	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.63	7.63	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	1.3	1.0	0.29	0.33	7.96	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.71	7.71	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	7.81	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.63	7.63	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	1.3	1.0	0.07	0.08	7.71	9.25	HGL ok
P-115	B5 West	MH-116	1.20	10.55	10.55	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	10.61	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.34	10.34	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	0.5	0.09	0.21	10.55	11.99	HGL ok
P-117	DI-117	DI-118	1.20	10.06	10.06	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	10.34	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.77	9.77	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	10.06	11.30	HGL ok
P-113	DI-113	DI-114	1.20	9.11	9.11	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	9.77	11.30	HGL ok
P-114	DI-114	MH-170	1.20	8.20	8.20	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	9.11	10.75	HGL ok
P-110	B4 South	MH-111	1.20	10.02	10.02	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	10.04	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.92	9.92	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.10	10.02	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.77	9.77	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	1.3	1.0	0.06	0.15	9.92	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.72	8.72	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.73	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.68	8.68	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.04	8.72	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.61	8.61	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	1.3	1.0	0.03	0.08	8.68	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.50	8.50	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	0.5	0.08	0.11	8.61	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.36	8.36	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	8.50	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	8.50	8.50	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.50	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.61	8.61	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	8.66	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.64	8.64	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.65	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.61	8.61	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.04	8.64	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.53	8.53	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	1.3	1.0	0.02	0.07	8.61	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.47	8.47	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	0.5	0.04	0.06	8.53	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.36	8.36	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	1.3	1.0	0.09	0.11	8.47	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.20	8.20	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	0.5	0.07	0.16	8.36	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.53	8.53	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.56	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.07	9.07	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.07	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.97	8.97	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	9.07	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.76	8.76	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	8.97	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.49	8.49	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	8.76	10.28	HGL ok
P-148	B3 West	MH-145	1.20	9.07	9.07	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.10	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	9.72	9.72	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.72	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.66	9.66	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	9.72	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.64	9.64	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.66	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	9.42	9.42	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	9.64	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.64	9.64	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	9.68	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	9.79	9.79	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.82	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.50	9.50	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	9.55	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.15	9.15	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	9.50	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	10.20	10.20	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.22	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.19	10.19	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.20	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.05	10.05	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	0.5	0.05	0.15	10.19	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	9.82	9.82	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	10.05	11.07	HGL ok
P-152	DI-152	MH-140	2.00	9.55	9.55	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	9.82	11.07	HGL ok
P-140	MH-140	DI-141	2.40	9.32	9.32	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	0.5	0.12	0.23	9.55	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.09	9.09	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	9.32	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.89	8.89	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	9.09	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.60	8.60	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	0.5	0.08	0.29	8.89	10.28	HGL ok
P-170	MH-170	MH-171	3.20	8.34	8.34	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	0.5	0.19	0.26	8.60	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.19	8.19	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	8.34	10.83	HGL ok
P-172	MH-172	MH-173	3.20	8.03	8.03	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	8.19	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	**0.5**	**0.12**	**0.23**	**8.03**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.34	8.34	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.34	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.34	8.34	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.34	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.19	8.19	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	8.25	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.19	8.19	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.06	8.25	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.36	8.36	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	8.93	10.50	HGL ok
P-179	DI-179	MH-173	1.00	8.03	8.03	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	1.3	1.0	0.29	0.33	8.36	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	8.11	8.11	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	8.21	10.50	HGL ok
P-181	DI-181	MH-173	1.00	8.03	8.03	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	1.3	1.0	0.07	0.08	8.11	9.25	HGL ok
P-115	B5 West	MH-116	1.20	10.95	10.95	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	11.01	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.74	10.74	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	0.5	0.09	0.21	10.95	11.99	HGL ok
P-117	DI-117	DI-118	1.20	10.46	10.46	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	10.74	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	10.17	10.17	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	10.46	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	9.51	9.51	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	10.17	11.30	HGL ok
P-114	DI-114	MH-170	1.20	8.60	8.60	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	9.51	10.75	HGL ok
P-110	B4 South	MH-111	1.20	10.42	10.42	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	10.44	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.32	10.32	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.10	10.42	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.17	10.17	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	1.3	1.0	0.06	0.15	10.32	11.71	HGL ok
P-120	DI-120	DI-121	1.00	9.12	9.12	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.13	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.08	9.08	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.04	9.12	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.01	9.01	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	1.3	1.0	0.03	0.08	9.08	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.90	8.90	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	0.5	0.08	0.11	9.01	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.76	8.76	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	8.90	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	8.90	8.90	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.90	10.67	HGL ok
P-126	B5 North	MH-123	1.20	9.01	9.01	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	9.06	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.04	9.04	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.05	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.01	9.01	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.04	9.04	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.93	8.93	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	1.3	1.0	0.02	0.07	9.01	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.87	8.87	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	0.5	0.04	0.06	8.93	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.76	8.76	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	1.3	1.0	0.09	0.11	8.87	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.60	8.60	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	0.5	0.07	0.16	8.76	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.93	8.93	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.96	10.00	HGL ok

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.47	9.47	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.47	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.37	9.37	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	9.47	10.87	HGL ok
P-146	DI-146	DI-147	1.20	9.16	9.16	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	9.37	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.89	8.89	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	9.16	10.28	HGL ok
P-148	B3 West	MH-145	1.20	9.47	9.47	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.50	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.12	10.12	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.12	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.06	10.06	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.12	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.04	10.04	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.06	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	9.82	9.82	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	10.04	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.04	10.04	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	10.08	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.19	10.19	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.22	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.90	9.90	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	9.95	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.55	9.55	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	9.90	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	13.24	13.24	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.26	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.23	13.23	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.24	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.09	13.09	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	0.5	0.05	0.15	13.23	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.86	12.86	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	13.09	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.59	12.59	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	12.86	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.36	12.36	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	0.5	0.12	0.23	12.59	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.13	12.13	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	12.36	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.93	11.93	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	12.13	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.64	11.64	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	0.5	0.08	0.29	11.93	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.38	11.38	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	0.5	0.19	0.26	11.64	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.23	11.23	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	11.38	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.07	11.07	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	11.23	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	**0.5**	**0.12**	**0.23**	**11.07**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.38	11.38	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.38	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.38	11.38	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.38	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.23	11.23	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	11.29	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.23	11.23	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.06	11.29	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.40	11.40	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	11.97	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.07	11.07	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	1.3	1.0	0.29	0.33	11.40	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.15	11.15	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	11.25	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.07	11.07	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	1.3	1.0	0.07	0.08	11.15	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.99	13.99	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	14.05	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.78	13.78	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	0.5	0.09	0.21	13.99	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.50	13.50	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	13.78	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.21	13.21	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	13.50	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.55	12.55	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	13.21	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.64	11.64	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	12.55	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.46	13.46	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	13.48	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.36	13.36	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.10	13.46	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.21	13.21	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	1.3	1.0	0.06	0.15	13.36	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.16	12.16	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.17	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.12	12.12	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.04	12.16	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.05	12.05	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	1.3	1.0	0.03	0.08	12.12	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.94	11.94	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	0.5	0.08	0.11	12.05	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.80	11.80	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	11.94	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.94	11.94	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.94	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.05	12.05	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	12.10	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.08	12.08	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.09	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.05	12.05	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.04	12.08	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.97	11.97	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	1.3	1.0	0.02	0.07	12.05	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.91	11.91	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	0.5	0.04	0.06	11.97	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.80	11.80	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	1.3	1.0	0.09	0.11	11.91	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.64	11.64	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	0.5	0.07	0.16	11.80	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.97	11.97	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.00	10.00	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.51	12.51	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.51	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.41	12.41	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	12.51	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.20	12.20	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	12.41	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.93	11.93	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	12.20	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.51	12.51	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.54	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.16	13.16	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.16	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.10	13.10	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.16	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.08	13.08	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.10	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.86	12.86	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	13.08	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.08	13.08	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	13.12	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.23	13.23	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.26	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.94	12.94	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	12.99	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.59	12.59	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	12.94	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 25 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

Location No.	Location From	Location To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	11.40	11.40	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.42	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.39	11.39	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.40	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.25	11.25	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	*0.5*	0.05	0.15	11.39	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.02	11.02	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	11.25	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.75	10.75	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	11.02	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.52	10.52	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	*0.5*	0.12	0.23	10.75	12.04	HGL ok
P-141	DI-141	DI-142	2.40	10.29	10.29	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	10.52	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.09	10.09	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	10.29	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.80	9.80	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	*0.5*	0.08	0.29	10.09	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.54	9.54	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	*0.5*	0.19	0.26	9.80	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.39	9.39	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	*0.5*	0.09	0.15	9.54	10.83	HGL ok
P-172	MH-172	MH-173	3.20	9.23	9.23	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	*0.5*	0.10	0.17	9.39	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	***0.5***	**0.12**	**0.23**	**9.23**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	9.54	9.54	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.54	10.61	HGL ok
P-175	DI-175	MH-171	1.20	9.54	9.54	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.54	10.63	HGL ok
P-176	B4 North	MH-172	1.20	9.39	9.39	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.06	9.45	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.39	9.39	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.06	9.45	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.56	9.56	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	10.13	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.23	9.23	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	*1.3*	1.0	0.29	0.33	9.56	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.31	9.31	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	9.41	10.50	HGL ok
P-181	DI-181	MH-173	1.00	9.23	9.23	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	*1.3*	1.0	0.07	0.08	9.31	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.15	12.15	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.02	0.05	12.21	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.94	11.94	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	*0.5*	0.09	0.21	12.15	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.66	11.66	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	11.94	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.37	11.37	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	11.66	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.71	10.71	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	11.37	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	9.80	9.80	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	10.71	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.62	11.62	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.02	11.64	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.52	11.52	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	*0.5*	0.04	0.10	11.62	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.37	11.37	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	*1.3*	1.0	0.06	0.15	11.52	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.32	10.32	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.33	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.28	10.28	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.04	10.32	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.21	10.21	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	*1.3*	1.0	0.03	0.08	10.28	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.10	10.10	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	*0.5*	0.08	0.11	10.21	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.96	9.96	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	10.10	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.10	10.10	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.10	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.21	10.21	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.02	0.05	10.26	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.24	10.24	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.25	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.21	10.21	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.04	10.24	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.13	10.13	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	*1.3*	1.0	0.02	0.07	10.21	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.07	10.07	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	*0.5*	0.04	0.06	10.13	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.96	9.96	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	*1.3*	1.0	0.09	0.11	10.07	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.80	9.80	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	*0.5*	0.07	0.16	9.96	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.13	10.13	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	10.16	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.67	10.67	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.67	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.57	10.57	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	10.67	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.36	10.36	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	10.57	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.09	10.09	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	10.36	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.67	10.67	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.70	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.32	11.32	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.32	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.26	11.26	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.32	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.24	11.24	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.26	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.02	11.02	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	11.24	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.24	11.24	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	11.28	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.39	11.39	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.42	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.10	11.10	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	11.15	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.75	10.75	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	11.10	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 25 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	11.90	11.90	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.92	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.89	11.89	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.90	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.75	11.75	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	0.5	0.05	0.15	11.89	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.52	11.52	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	11.75	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.25	11.25	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	11.52	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.02	11.02	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	0.5	0.12	0.23	11.25	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	10.79	10.79	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	11.02	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.59	10.59	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	10.79	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.30	10.30	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	0.5	0.08	0.29	10.59	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.04	10.04	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	0.5	0.19	0.26	10.30	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	9.89	9.89	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	10.04	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.73	9.73	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	9.89	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	**0.5**	**0.12**	**0.23**	**9.73**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.04	10.04	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.04	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.04	10.04	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.04	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.89	9.89	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	9.95	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.89	9.89	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.06	9.95	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.06	10.06	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	10.63	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.73	9.73	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	1.3	1.0	0.29	0.33	10.06	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.81	9.81	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	9.91	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.73	9.73	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	1.3	1.0	0.07	0.08	9.81	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.65	12.65	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	12.71	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.44	12.44	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	0.5	0.09	0.21	12.65	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.16	12.16	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	12.44	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.87	11.87	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	12.16	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.21	11.21	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	11.87	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.30	10.30	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	11.21	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.12	12.12	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	12.14	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.02	12.02	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.10	12.12	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.87	11.87	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	1.3	1.0	0.06	0.15	12.02	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.82	10.82	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.83	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.78	10.78	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.04	10.82	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.71	10.71	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	1.3	1.0	0.03	0.08	10.78	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.60	10.60	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	0.5	0.08	0.11	10.71	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.46	10.46	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	10.60	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.60	10.60	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.60	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.71	10.71	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	10.76	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.74	10.74	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.75	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.71	10.71	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.04	10.74	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.63	10.63	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	1.3	1.0	0.02	0.07	10.71	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.57	10.57	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	0.5	0.04	0.06	10.63	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.46	10.46	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	1.3	1.0	0.09	0.11	10.57	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.30	10.30	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	0.5	0.07	0.16	10.46	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.63	10.63	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.66	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.17	11.17	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.17	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.07	11.07	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	11.17	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.86	10.86	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	11.07	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.59	10.59	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	10.86	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.17	11.17	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.20	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.82	11.82	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.82	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.76	11.76	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.82	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.74	11.74	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.76	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.52	11.52	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	11.74	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.74	11.74	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	11.78	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.89	11.89	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.92	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.60	11.60	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	11.65	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.25	11.25	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	11.60	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	13.20	13.20	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.22	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.19	13.19	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.20	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.05	13.05	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	*0.5*	0.05	0.15	13.19	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.82	12.82	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	13.05	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.55	12.55	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	12.82	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.32	12.32	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	*0.5*	0.12	0.23	12.55	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.09	12.09	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	12.32	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.89	11.89	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	12.09	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.60	11.60	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	*0.5*	0.08	0.29	11.89	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.34	11.34	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	*0.5*	0.19	0.26	11.60	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.19	11.19	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	*0.5*	0.09	0.15	11.34	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.03	11.03	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	*0.5*	0.10	0.17	11.19	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	***0.5***	**0.12**	**0.23**	**11.03**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.34	11.34	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.34	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.34	11.34	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.34	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.19	11.19	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.06	11.25	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.19	11.19	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.06	11.25	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.36	11.36	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	11.93	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.03	11.03	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	*1.3*	1.0	0.29	0.33	11.36	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.11	11.11	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	11.21	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.03	11.03	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	*1.3*	1.0	0.07	0.08	11.11	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.95	13.95	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.02	0.05	14.01	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.74	13.74	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	*0.5*	0.09	0.21	13.95	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.46	13.46	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	13.74	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.17	13.17	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	13.46	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.51	12.51	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	13.17	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.60	11.60	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	12.51	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.42	13.42	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.02	13.44	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.32	13.32	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	*0.5*	0.04	0.10	13.42	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.17	13.17	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	*1.3*	1.0	0.06	0.15	13.32	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.12	12.12	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.13	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.08	12.08	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.04	12.12	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.01	12.01	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	*1.3*	1.0	0.03	0.08	12.08	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.90	11.90	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	*0.5*	0.08	0.11	12.01	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.76	11.76	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	11.90	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.90	11.90	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.90	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.01	12.01	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.02	0.05	12.06	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.04	12.04	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.05	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.01	12.01	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.04	12.04	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.93	11.93	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	*1.3*	1.0	0.02	0.07	12.01	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.87	11.87	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	*0.5*	0.04	0.06	11.93	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.76	11.76	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	*1.3*	1.0	0.09	0.11	11.87	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.60	11.60	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	*0.5*	0.07	0.16	11.76	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.93	11.93	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	11.96	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.47	12.47	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.47	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.37	12.37	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	12.47	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.16	12.16	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	12.37	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.89	11.89	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	12.16	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.47	12.47	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.50	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.12	13.12	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.12	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.06	13.06	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.12	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.04	13.04	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.06	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.82	12.82	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	13.04	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.04	13.04	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	13.08	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.19	13.19	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.22	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.90	12.90	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	12.95	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.55	12.55	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	12.90	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	8.14	8.14	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.16	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	8.13	8.13	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.14	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	7.99	7.99	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	0.5	0.05	0.15	8.13	10.06	HGL ok
P-156	DI-156	DI-152	1.20	7.76	7.76	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	7.99	11.07	HGL ok
P-152	DI-152	MH-140	2.00	7.49	7.49	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	7.76	11.07	HGL ok
P-140	MH-140	DI-141	2.40	7.26	7.26	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	0.5	0.12	0.23	7.49	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.03	7.03	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	7.26	11.02	HGL ok
P-142	DI-142	DI-143	2.40	6.83	6.83	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	7.03	10.52	HGL ok
P-143	DI-143	MH-170	2.40	6.54	6.54	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	0.5	0.08	0.29	6.83	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.28	6.28	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	0.5	0.19	0.26	6.54	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.13	6.13	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	6.28	10.83	HGL ok
P-172	MH-172	MH-173	3.20	5.97	5.97	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	6.13	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	**0.5**	**0.12**	**0.23**	**5.97**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.28	6.28	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.28	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.28	6.28	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.28	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.13	6.13	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	6.19	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.13	6.13	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.06	6.19	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.30	6.30	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	6.87	10.50	HGL ok
P-179	DI-179	MH-173	1.00	5.97	5.97	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	1.3	1.0	0.29	0.33	6.30	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.05	6.78	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	6.89	10.50	HGL ok
P-181	DI-181	MH-173	1.00	5.97	5.97	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	1.3	1.0	0.07	0.08	6.05	9.25	HGL ok
P-115	B5 West	MH-116	1.20	8.89	8.89	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	8.95	10.00	HGL ok
P-116	MH-116	DI-117	1.20	8.68	8.68	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	0.5	0.09	0.21	8.89	11.99	HGL ok
P-117	DI-117	DI-118	1.20	8.40	8.40	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	8.68	11.71	HGL ok
P-118	DI-118	DI-113	1.20	8.11	8.11	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	8.40	11.30	HGL ok
P-113	DI-113	DI-114	1.20	7.45	7.45	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	8.11	11.30	HGL ok
P-114	DI-114	MH-170	1.20	6.54	6.54	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	7.45	10.75	HGL ok
P-110	B4 South	MH-111	1.20	8.36	8.36	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	8.38	10.00	HGL ok
P-111	MH-111	DI-112	1.20	8.26	8.26	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.10	8.36	11.99	HGL ok
P-112	DI-112	DI-113	1.20	8.11	8.11	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	1.3	1.0	0.06	0.15	8.26	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.06	7.06	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.07	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.02	7.02	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.04	7.06	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	6.95	6.95	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	1.3	1.0	0.03	0.08	7.02	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	6.84	6.84	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	0.5	0.08	0.11	6.95	8.91	HGL ok
P-124	DI-124	MH-135	1.60	6.70	6.70	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	6.84	9.44	HGL ok
P-125	DI-125	DI-124	1.00	6.84	6.84	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.84	10.67	HGL ok
P-126	B5 North	MH-123	1.20	6.95	6.95	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	7.00	10.00	HGL ok
P-130	DI-130	DI-131	1.00	6.98	6.98	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.99	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	6.95	6.95	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.04	6.98	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	6.87	6.87	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	1.3	1.0	0.02	0.07	6.95	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	6.81	6.81	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	0.5	0.04	0.06	6.87	8.91	HGL ok
P-134	DI-134	MH-135	1.60	6.70	6.70	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	1.3	1.0	0.09	0.11	6.81	9.44	HGL ok
P-135	MH-135	MH-170	2.00	6.54	6.54	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	0.5	0.07	0.16	6.70	10.15	HGL ok
P-136	B3 South	MH-133	1.20	6.87	6.87	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	6.90	10.00	HGL ok

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	7.41	7.41	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.41	11.02	HGL ok
P-145	MH-145	DI-146	1.20	7.31	7.31	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	7.41	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.10	7.10	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	7.31	10.52	HGL ok
P-147	DI-147	DI-143	1.20	6.83	6.83	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	7.10	10.28	HGL ok
P-148	B3 West	MH-145	1.20	7.41	7.41	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	7.44	10.00	HGL ok
P-167	DI-167	DI-159	1.00	8.06	8.06	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.06	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	8.00	8.00	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	8.06	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	7.98	7.98	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.00	9.06	HGL ok
P-151	MH-151	DI-152	1.60	7.76	7.76	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	7.98	10.06	HGL ok
P-153	B1	MH-151	1.60	7.98	7.98	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	8.02	10.00	HGL ok
P-157	B3 North	MH-155	1.20	8.13	8.13	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.16	10.00	HGL ok
P-166	B2 North	MH-163	1.20	7.84	7.84	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	7.89	10.00	HGL ok
P-163	MH-163	MH-140	1.20	7.49	7.49	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	7.84	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 25 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	8.34	8.34	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.36	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	8.33	8.33	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.34	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	8.19	8.19	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	*0.5*	0.05	0.15	8.33	10.06	HGL ok
P-156	DI-156	DI-152	1.20	7.96	7.96	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	8.19	11.07	HGL ok
P-152	DI-152	MH-140	2.00	7.69	7.69	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	7.96	11.07	HGL ok
P-140	MH-140	DI-141	2.40	7.46	7.46	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	*0.5*	0.12	0.23	7.69	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.23	7.23	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	7.46	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.03	7.03	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	7.23	10.52	HGL ok
P-143	DI-143	MH-170	2.40	6.74	6.74	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	*0.5*	0.08	0.29	7.03	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.48	6.48	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	*0.5*	0.19	0.26	6.74	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.33	6.33	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	*0.5*	0.09	0.15	6.48	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.17	6.17	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	*0.5*	0.10	0.17	6.33	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	***0.5***	**0.12**	**0.23**	**6.17**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.48	6.48	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.48	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.48	6.48	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.48	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.33	6.33	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.06	6.39	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.33	6.33	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.06	6.39	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.50	6.50	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	7.07	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.17	6.17	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	*1.3*	1.0	0.29	0.33	6.50	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.25	6.78	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	6.89	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.17	6.17	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	*1.3*	1.0	0.07	0.08	6.25	9.25	HGL ok
P-115	B5 West	MH-116	1.20	9.09	9.09	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.02	0.05	9.15	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	8.88	8.88	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	*0.5*	0.09	0.21	9.09	11.99	HGL ok
P-117	DI-117	DI-118	1.20	8.60	8.60	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	8.88	11.71	HGL ok
P-118	DI-118	DI-113	1.20	8.31	8.31	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	8.60	11.30	HGL ok
P-113	DI-113	DI-114	1.20	7.65	7.65	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	8.31	11.30	HGL ok
P-114	DI-114	MH-170	1.20	6.74	6.74	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	7.65	10.75	HGL ok
P-110	B4 South	MH-111	1.20	8.56	8.56	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.02	8.58	10.00	HGL ok
P-111	MH-111	DI-112	1.20	8.46	8.46	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	*0.5*	0.04	0.10	8.56	11.99	HGL ok
P-112	DI-112	DI-113	1.20	8.31	8.31	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	*1.3*	1.0	0.06	0.15	8.46	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.26	7.26	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.27	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.22	7.22	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.04	7.26	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.15	7.15	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	*1.3*	1.0	0.03	0.08	7.22	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.04	7.04	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	*0.5*	0.08	0.11	7.15	8.91	HGL ok
P-124	DI-124	MH-135	1.60	6.90	6.90	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	7.04	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.04	7.04	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.04	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.15	7.15	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.02	0.05	7.20	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.18	7.18	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.19	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.15	7.15	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.04	7.18	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.07	7.07	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	*1.3*	1.0	0.02	0.07	7.15	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.01	7.01	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	*0.5*	0.04	0.06	7.07	8.91	HGL ok
P-134	DI-134	MH-135	1.60	6.90	6.90	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	*1.3*	1.0	0.09	0.11	7.01	9.44	HGL ok
P-135	MH-135	MH-170	2.00	6.74	6.74	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	*0.5*	0.07	0.16	6.90	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.07	7.07	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	7.10	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	7.61	7.61	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.61	11.02	HGL ok
P-145	MH-145	DI-146	1.20	7.51	7.51	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	7.61	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.30	7.30	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	7.51	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.03	7.03	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	7.30	10.28	HGL ok
P-148	B3 West	MH-145	1.20	7.61	7.61	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	7.64	10.00	HGL ok
P-167	DI-167	DI-159	1.00	8.26	8.26	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.26	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	8.20	8.20	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	8.26	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	8.18	8.18	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.20	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	7.96	7.96	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	8.18	10.06	HGL ok
P-153	B1	MH-151	1.60	8.18	8.18	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	8.22	10.00	HGL ok
P-157	B3 North	MH-155	1.20	8.33	8.33	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.36	10.00	HGL ok
P-166	B2 North	MH-163	1.20	8.04	8.04	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	8.09	10.00	HGL ok
P-163	MH-163	MH-140	1.20	7.69	7.69	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	8.04	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add $Hc = 0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\ adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\ adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	**HGL Check**
P-158	DI-158	DI-154	1.00	11.84	11.84	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.86	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.83	11.83	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.84	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.69	11.69	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	*0.5*	0.05	0.15	11.83	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.46	11.46	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	11.69	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.19	11.19	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	11.46	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.96	10.96	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	*0.5*	0.12	0.23	11.19	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	10.73	10.73	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	10.96	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.53	10.53	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	10.73	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.24	10.24	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	*0.5*	0.08	0.29	10.53	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.98	9.98	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	*0.5*	0.19	0.26	10.24	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	9.83	9.83	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	*0.5*	0.09	0.15	9.98	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.67	9.67	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	*0.5*	0.10	0.17	9.83	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	***0.5***	**0.12**	**0.23**	**9.67**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	9.98	9.98	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.98	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	9.98	9.98	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.98	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.83	9.83	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.06	9.89	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.83	9.83	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.06	9.89	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.00	10.00	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	10.57	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.67	9.67	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	*1.3*	1.0	0.29	0.33	10.00	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.75	9.75	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	9.85	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.67	9.67	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	*1.3*	1.0	0.07	0.08	9.75	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.59	12.59	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.02	0.05	12.65	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.38	12.38	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	*0.5*	0.09	0.21	12.59	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.10	12.10	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	12.38	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.81	11.81	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	12.10	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.15	11.15	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	11.81	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.24	10.24	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	11.15	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.06	12.06	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.02	12.08	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.96	11.96	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	*0.5*	0.04	0.10	12.06	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.81	11.81	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	*1.3*	1.0	0.06	0.15	11.96	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.76	10.76	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.77	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.72	10.72	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.04	10.76	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.65	10.65	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	*1.3*	1.0	0.03	0.08	10.72	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.54	10.54	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	*0.5*	0.08	0.11	10.65	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.40	10.40	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	10.54	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.54	10.54	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.54	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.65	10.65	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.02	0.05	10.70	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.68	10.68	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.69	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.65	10.65	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.04	10.68	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.57	10.57	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	*1.3*	1.0	0.02	0.07	10.65	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.51	10.51	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	*0.5*	0.04	0.06	10.57	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.40	10.40	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	*1.3*	1.0	0.09	0.11	10.51	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.24	10.24	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	*0.5*	0.07	0.16	10.40	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.57	10.57	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	10.60	10.00	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.11	11.11	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.11	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.01	11.01	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	11.11	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.80	10.80	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	11.01	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.53	10.53	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	10.80	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.11	11.11	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.14	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.76	11.76	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.76	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.70	11.70	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.76	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.68	11.68	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.70	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.46	11.46	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	11.68	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.68	11.68	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	11.72	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.83	11.83	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.86	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.54	11.54	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	11.59	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.19	11.19	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	11.54	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)		

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D — 0.8D (ft)	Tailwater, link to Inlet WSE of downstream pipe — TW (ft)	Outlet W. S. Elevation — HGL Dn (ft)	Outflow Pipe Diameter — D_o (in)	Outflow Pipe Design Flow — Q_o (cfs)	Pressure-flow Vel., $V_o=Q_o/A$ — V_o (fps)	Skew angle vs. — Δ_o (deg)	Outflow Pipe Length — L (ft)	Friction Slope — S_{fo} (ft/ft)	Friction Loss — H_f (ft)	Angle of Curvature — O (deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ — H_c (ft)	Contraction Loss — H_o (ft)	Q*V for determining controlling inflow pipe — Q1V1 (ft^4/s^2)	Q*V for determining controlling inflow pipe — Q2V2 (ft^4/s^2)	Q*V for determining controlling inflow pipe — Q3V3 (ft^4/s^2)	Controlling Inflow Velocity — Vi	Expansion Loss — Hi (ft)	Controlling In-flow skew — Δ_i (deg)	Bend Loss — H_Δ (ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ — H_t (cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss — $H_{t\,adj}$ (ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ — H (ft)	Inlet W. S. Elevation — HGL Up (ft)	Top of Grate — T/G (ft)	HGL Check
P-158	DI-158	DI-154	1.00	12.34	12.34	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.36	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.33	12.33	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.34	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.19	12.19	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	0.5	0.05	0.15	12.33	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.96	11.96	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	12.19	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.69	11.69	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	11.96	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.46	11.46	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	0.5	0.12	0.23	11.69	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.23	11.23	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	11.46	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.03	11.03	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	11.23	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.74	10.74	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	0.5	0.08	0.29	11.03	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.48	10.48	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	0.5	0.19	0.26	10.74	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.33	10.33	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	10.48	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.17	10.17	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	10.33	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	**0.5**	**0.12**	**0.23**	**10.17**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.48	10.48	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.48	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.48	10.48	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.48	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.33	10.33	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	10.39	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.33	10.33	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.06	10.39	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.50	10.50	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	11.07	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.17	10.17	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	1.3	1.0	0.29	0.33	10.50	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.25	10.25	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	10.35	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.17	10.17	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	1.3	1.0	0.07	0.08	10.25	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.09	13.09	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	13.15	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.88	12.88	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	0.5	0.09	0.21	13.09	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.60	12.60	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	12.88	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.31	12.31	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	12.60	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.65	11.65	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	12.31	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.74	10.74	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	11.65	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.56	12.56	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	12.58	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.46	12.46	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.10	12.56	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.31	12.31	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	1.3	1.0	0.06	0.15	12.46	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.26	11.26	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.27	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.22	11.22	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.04	11.26	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.15	11.15	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	1.3	1.0	0.03	0.08	11.22	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.04	11.04	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	0.5	0.08	0.11	11.15	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.90	10.90	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	11.04	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.04	11.04	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.04	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.15	11.15	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	11.20	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.18	11.18	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.19	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.15	11.15	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.04	11.18	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.07	11.07	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	1.3	1.0	0.02	0.07	11.15	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.01	11.01	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	0.5	0.04	0.06	11.07	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.90	10.90	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	1.3	1.0	0.09	0.11	11.01	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.74	10.74	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	0.5	0.07	0.16	10.90	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.07	11.07	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.10	10.00	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.61	11.61	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.61	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.51	11.51	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	11.61	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.30	11.30	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	11.51	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.03	11.03	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	11.30	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.61	11.61	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.64	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.26	12.26	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.26	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.20	12.20	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.26	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.18	12.18	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.20	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.96	11.96	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	12.18	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.18	12.18	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	12.22	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.33	12.33	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.36	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.04	12.04	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	12.09	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.69	11.69	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	12.04	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 25 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta +H_c$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.74	12.74	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.76	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.73	12.73	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.74	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.59	12.59	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	0.5	0.05	0.15	12.73	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.36	12.36	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	12.59	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.09	12.09	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	12.36	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.86	11.86	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	0.5	0.12	0.23	12.09	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.63	11.63	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	11.86	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.43	11.43	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	11.63	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.14	11.14	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	0.5	0.08	0.29	11.43	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.88	10.88	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	0.5	0.19	0.26	11.14	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.73	10.73	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	10.88	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.57	10.57	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	10.73	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	**0.5**	**0.12**	**0.23**	**10.57**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.88	10.88	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.88	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.88	10.88	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.88	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.73	10.73	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	10.79	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.73	10.73	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.06	10.79	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.90	10.90	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	11.47	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.57	10.57	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	1.3	1.0	0.29	0.33	10.90	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.65	10.65	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	10.75	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.57	10.57	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	1.3	1.0	0.07	0.08	10.65	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.49	13.49	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	13.55	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.28	13.28	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	0.5	0.09	0.21	13.49	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.00	13.00	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	13.28	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.71	12.71	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	13.00	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.05	12.05	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	12.71	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.14	11.14	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	12.05	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.96	12.96	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	12.98	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.86	12.86	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.10	12.96	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.71	12.71	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	1.3	1.0	0.06	0.15	12.86	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.66	11.66	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.67	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.62	11.62	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.04	11.66	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.55	11.55	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	1.3	1.0	0.03	0.08	11.62	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.44	11.44	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	0.5	0.08	0.11	11.55	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.30	11.30	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	11.44	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.44	11.44	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.44	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.55	11.55	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	11.60	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.58	11.58	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.59	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.55	11.55	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.04	11.58	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.47	11.47	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	1.3	1.0	0.02	0.07	11.55	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.41	11.41	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	0.5	0.04	0.06	11.47	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.30	11.30	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	1.3	1.0	0.09	0.11	11.41	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.14	11.14	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	0.5	0.07	0.16	11.30	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.47	11.47	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.50	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.01	12.01	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.01	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.91	11.91	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	12.01	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.70	11.70	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	11.91	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.43	11.43	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	11.70	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.01	12.01	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.04	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.66	12.66	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.66	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.60	12.60	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.66	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.58	12.58	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.60	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.36	12.36	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	12.58	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.58	12.58	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	12.62	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.73	12.73	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.76	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.44	12.44	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	12.49	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.09	12.09	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	12.44	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add $H_c = 0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	13.24	13.24	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.26	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.23	13.23	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.24	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.09	13.09	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	0.5	0.05	0.15	13.23	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.86	12.86	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	13.09	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.59	12.59	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	12.86	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.36	12.36	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	0.5	0.12	0.23	12.59	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.13	12.13	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	12.36	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.93	11.93	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	12.13	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.64	11.64	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	0.5	0.08	0.29	11.93	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.38	11.38	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	0.5	0.19	0.26	11.64	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.23	11.23	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	11.38	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.07	11.07	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	11.23	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	**0.5**	**0.12**	**0.23**	**11.07**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.38	11.38	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.38	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.38	11.38	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.38	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.23	11.23	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	11.29	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.23	11.23	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.06	11.29	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.40	11.40	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	11.97	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.07	11.07	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	1.3	1.0	0.29	0.33	11.40	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.15	11.15	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	11.25	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.07	11.07	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	1.3	1.0	0.07	0.08	11.15	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.99	13.99	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	14.05	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.78	13.78	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	0.5	0.09	0.21	13.99	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.50	13.50	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	13.78	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.21	13.21	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	13.50	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.55	12.55	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	13.21	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.64	11.64	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	12.55	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.46	13.46	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	13.48	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.36	13.36	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.10	13.46	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.21	13.21	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	1.3	1.0	0.06	0.15	13.36	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.16	12.16	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.17	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.12	12.12	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.04	12.16	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.05	12.05	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	1.3	1.0	0.03	0.08	12.12	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.94	11.94	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	0.5	0.08	0.11	12.05	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.80	11.80	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	11.94	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.94	11.94	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.94	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.05	12.05	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	12.10	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.08	12.08	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.09	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.05	12.05	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.04	12.08	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.97	11.97	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	1.3	1.0	0.02	0.07	12.05	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.91	11.91	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	0.5	0.04	0.06	11.97	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.80	11.80	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	1.3	1.0	0.09	0.11	11.91	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.64	11.64	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	0.5	0.07	0.16	11.80	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.97	11.97	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.00	10.00	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.51	12.51	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.51	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.41	12.41	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	12.51	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.20	12.20	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	12.41	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.93	11.93	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	12.20	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.51	12.51	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.54	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.16	13.16	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.16	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.10	13.10	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.16	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.08	13.08	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.10	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.86	12.86	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	13.08	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.08	13.08	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	13.12	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.23	13.23	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.26	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.94	12.94	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	12.99	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.59	12.59	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	12.94	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 25 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	**HGL Check**
P-158	DI-158	DI-154	1.00	13.94	13.94	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.96	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.93	13.93	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.94	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.79	13.79	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	*0.5*	0.05	0.15	13.93	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.56	13.56	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	13.79	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	13.29	13.29	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	13.56	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	13.06	13.06	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	*0.5*	0.12	0.23	13.29	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.83	12.83	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	13.06	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.63	12.63	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	12.83	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.34	12.34	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	*0.5*	0.08	0.29	12.63	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.08	12.08	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	*0.5*	0.19	0.26	12.34	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.93	11.93	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	*0.5*	0.09	0.15	12.08	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.77	11.77	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	*0.5*	0.10	0.17	11.93	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	***0.5***	**0.12**	**0.23**	**11.77**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.08	12.08	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.08	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.08	12.08	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.08	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.93	11.93	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.06	11.99	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.93	11.93	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	*0.5*	0.01	0.06	11.99	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.10	12.10	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	12.67	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.77	11.77	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	*1.3*	1.0	0.29	0.33	12.10	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.85	11.85	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	11.95	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.77	11.77	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	*1.3*	1.0	0.07	0.08	11.85	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.69	14.69	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.02	0.05	14.75	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.48	14.48	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	*0.5*	0.09	0.21	14.69	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.20	14.20	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	14.48	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.91	13.91	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	14.20	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.25	13.25	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	13.91	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.34	12.34	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	13.25	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.16	14.16	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.02	14.18	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.06	14.06	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	*0.5*	0.04	0.10	14.16	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.91	13.91	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	*1.3*	1.0	0.06	0.15	14.06	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.86	12.86	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.87	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.82	12.82	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.04	12.86	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.75	12.75	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	*1.3*	1.0	0.03	0.08	12.82	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.64	12.64	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	*0.5*	0.08	0.11	12.75	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.50	12.50	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	12.64	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.64	12.64	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.64	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.75	12.75	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.02	0.05	12.80	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.78	12.78	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.79	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.75	12.75	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.04	12.78	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.67	12.67	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	*1.3*	1.0	0.02	0.07	12.75	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.61	12.61	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	*0.5*	0.04	0.06	12.67	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.50	12.50	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	*1.3*	1.0	0.09	0.11	12.61	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.34	12.34	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	*0.5*	0.07	0.16	12.50	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.67	12.67	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	12.70	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	13.21	13.21	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.21	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.11	13.11	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	13.21	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.90	12.90	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	13.11	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.63	12.63	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	12.90	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	13.21	13.21	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.24	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.86	13.86	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.86	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.80	13.80	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.86	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.78	13.78	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.80	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.56	13.56	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	13.78	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.78	13.78	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	13.82	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.93	13.93	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.96	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.64	13.64	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	13.69	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.29	13.29	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	13.64	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H=H_f+H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	14.44	14.44	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.46	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	14.43	14.43	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.44	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	14.29	14.29	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	0.5	0.05	0.15	14.43	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	14.06	14.06	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	14.29	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	13.79	13.79	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	14.06	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	13.56	13.56	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	0.5	0.12	0.23	13.79	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	13.33	13.33	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	13.56	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	13.13	13.13	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	13.33	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.84	12.84	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	0.5	0.08	0.29	13.13	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.58	12.58	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	0.5	0.19	0.26	12.84	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	12.43	12.43	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	12.58	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	12.27	12.27	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	12.43	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	**0.5**	**0.12**	**0.23**	**12.27**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.58	12.58	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.58	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.58	12.58	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.58	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	12.43	12.43	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	12.49	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	12.43	12.43	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.06	12.49	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.60	12.60	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	13.17	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	12.27	12.27	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	1.3	1.0	0.29	0.33	12.60	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	12.35	12.35	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	12.45	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	12.27	12.27	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	1.3	1.0	0.07	0.08	12.35	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	15.19	15.19	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	15.25	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.98	14.98	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	0.5	0.09	0.21	15.19	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.70	14.70	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	14.98	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	14.41	14.41	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	14.70	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.75	13.75	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	14.41	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.84	12.84	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	13.75	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.66	14.66	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	14.68	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.56	14.56	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.10	14.66	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	14.41	14.41	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	1.3	1.0	0.06	0.15	14.56	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	13.36	13.36	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.37	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	13.32	13.32	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.04	13.36	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	13.25	13.25	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	1.3	1.0	0.03	0.08	13.32	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	13.14	13.14	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	0.5	0.08	0.11	13.25	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	13.00	13.00	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	13.14	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	13.14	13.14	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.14	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	13.25	13.25	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	13.30	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	13.28	13.28	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.29	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	13.25	13.25	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.04	13.28	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	13.17	13.17	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	1.3	1.0	0.02	0.07	13.25	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	13.11	13.11	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	0.5	0.04	0.06	13.17	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	13.00	13.00	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	1.3	1.0	0.09	0.11	13.11	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.84	12.84	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	0.5	0.07	0.16	13.00	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	13.17	13.17	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.20	10.00	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	13.71	13.71	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.71	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.61	13.61	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	13.71	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	13.40	13.40	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	13.61	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	13.13	13.13	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	13.40	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	13.71	13.71	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.74	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	14.36	14.36	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.36	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	14.30	14.30	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	14.36	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	14.28	14.28	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	14.30	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	14.06	14.06	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	14.28	10.06	HGL Too High!
P-153	B1	MH-151	1.60	14.28	14.28	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	14.32	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	14.43	14.43	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.46	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	14.14	14.14	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	14.19	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.79	13.79	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	14.14	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 25 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)
P-158	DI-158	DI-154	1.00	15.74	15.74	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00
P-154	DI-154	MH-155	1.00	15.73	15.73	15	1.1	0.9	10	24	0.0002	0.01	0	0.00	0.00
P-155	MH-155	DI-156	1.20	15.59	15.59	18	4.8	2.7	89	51	0.0018	0.09	0	0.00	0.03
P-156	DI-156	DI-152	1.20	15.36	15.36	18	5.2	2.9	94	33	0.0021	0.07	0	0.00	0.03
P-152	DI-152	MH-140	2.00	15.09	15.09	30	16.7	3.4	85	97	0.0014	0.14	0	0.00	0.04
P-140	MH-140	DI-141	2.40	14.86	14.86	36	24.7	3.5	2	97	0.0012	0.11	0	0.00	0.05
P-141	DI-141	DI-142	2.40	14.63	14.63	36	24.9	3.5	1	96	0.0012	0.11	0	0.00	0.05
P-142	DI-142	DI-143	2.40	14.43	14.43	36	25.2	3.6	5	68	0.0012	0.08	0	0.00	0.05
P-143	DI-143	MH-170	2.40	14.14	14.14	36	31.0	4.4	86	115	0.0018	0.21	0	0.00	0.07
P-170	MH-170	MH-171	3.20	13.88	13.88	48	54.2	4.3	0	55	0.0012	0.07	0	0.00	0.07
P-171	MH-171	MH-172	3.20	13.73	13.73	48	55.1	4.4	0	50	0.0013	0.06	0	0.00	0.07
P-172	MH-172	MH-173	3.20	13.57	13.57	48	61.1	4.9	0	44	0.0015	0.07	0	0.00	0.09
P-173	**MH-173**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**64.7**	**5.1**	**0**	**64**	**0.0017**	**0.11**	**0**	**0.00**	**0.10**
P-174	DI-174	MH-171	1.20	13.88	13.88	18	0.6	0.3	90	33	0.0000	0.00	0	0.00	0.00
P-175	DI-175	MH-171	1.20	13.88	13.88	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00
P-176	B4 North	MH-172	1.20	13.73	13.73	18	3.6	2.0	90	55	0.0010	0.05	0	0.00	0.02
P-177	B2 South	MH-172	1.20	13.73	13.73	18	3.4	1.9	90	55	0.0009	0.05	0	0.00	0.01
P-178	TD-03	DI-179	0.53	13.90	13.90	8	1.4	3.9	56	56	0.0091	0.51	0	0.00	0.06
P-179	DI-179	MH-173	1.00	13.57	13.57	15	2.5	2.0	90	30	0.0013	0.04	0	0.00	0.02
P-180	TD-02	DI-181	0.53	13.65	13.65	8	0.6	1.8	45	45	0.0020	0.09	0	0.00	0.01
P-181	DI-181	MH-173	1.00	13.57	13.57	15	1.7	1.4	90	30	0.0006	0.02	0	0.00	0.01
P-115	B5 West	MH-116	1.20	16.49	16.49	18	5.3	3.0	86	17	0.0021	0.04	0	0.00	0.03
P-116	MH-116	DI-117	1.20	16.28	16.28	18	5.2	3.0	4	60	0.0021	0.13	0	0.00	0.03
P-117	DI-117	DI-118	1.20	16.00	16.00	18	5.7	3.2	89	71	0.0025	0.18	0	0.00	0.04
P-118	DI-118	DI-113	1.20	15.71	15.71	18	6.1	3.4	72	27	0.0029	0.08	0	0.00	0.05
P-113	DI-113	DI-114	1.20	15.05	15.05	18	10.5	5.9	25	41	0.0085	0.35	0	0.00	0.14
P-114	DI-114	MH-170	1.20	14.14	14.14	18	10.7	6.0	97	47	0.0088	0.41	0	0.00	0.14
P-110	B4 South	MH-111	1.20	15.96	15.96	18	3.6	2.0	86	17	0.0010	0.02	0	0.00	0.02
P-111	MH-111	DI-112	1.20	15.86	15.86	18	3.6	2.0	4	60	0.0010	0.06	0	0.00	0.02
P-112	DI-112	DI-113	1.20	15.71	15.71	18	4.0	2.3	19	71	0.0012	0.09	0	0.00	0.02
P-120	DI-120	DI-121	1.00	14.66	14.66	15	0.5	0.4	2	22	0.0000	0.00	0	0.00	0.00
P-121	DI-121	DI-122	1.00	14.62	14.62	15	1.4	1.1	7	84	0.0004	0.03	0	0.00	0.01
P-122	DI-122	MH-123	1.00	14.55	14.55	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01
P-123	MH-123	DI-124	1.60	14.44	14.44	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02
P-124	DI-124	MH-135	1.60	14.30	14.30	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02
P-125	DI-125	DI-124	1.00	14.44	14.44	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00
P-126	B5 North	MH-123	1.20	14.55	14.55	18	5.2	3.0	81	17	0.0021	0.04	0	0.00	0.03
P-130	DI-130	DI-131	1.00	14.58	14.58	15	0.4	0.4	6	22	0.0000	0.00	0	0.00	0.00
P-131	DI-131	DI-132	1.00	14.55	14.55	15	1.3	1.1	5	83	0.0004	0.03	0	0.00	0.00
P-132	DI-132	MH-133	1.00	14.47	14.47	15	2.1	1.7	14	56	0.0009	0.05	0	0.00	0.01
P-133	MH-133	DI-134	1.60	14.41	14.41	24	5.7	1.8	81	36	0.0005	0.02	0	0.00	0.01
P-134	DI-134	MH-135	1.60	14.30	14.30	24	6.4	2.0	90	31	0.0007	0.02	0	0.00	0.02
P-135	MH-135	MH-170	2.00	14.14	14.14	30	14.1	2.9	0	94	0.0010	0.10	0	0.00	0.03
P-136	B3 South	MH-133	1.20	14.47	14.47	18	3.9	2.2	81	17	0.0011	0.02	0	0.00	0.02

No.	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.76	7.70	HGL Too High!
P-154	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.74	9.06	HGL Too High!
P-155	1.0	8.4	0.0	2.2	0.0	89	0.05	0.11	1.0	0.5	0.05	0.15	15.73	10.06	HGL Too High!
P-156	13.2	0.0	0.0	2.7	0.0	89	0.08	0.16	1.0	1.0	0.16	0.22	15.59	11.07	HGL Too High!
P-152	15.3	41.4	0.0	3.6	0.1	3	0.02	0.14	1.0	1.0	0.14	0.27	15.36	11.07	HGL Too High!
P-140	56.7	41.9	0.0	3.4	0.1	85	0.12	0.23	1.0	0.5	0.12	0.23	15.09	12.04	HGL Too High!
P-141	86.1	0.0	0.0	3.5	0.1	2	0.00	0.11	1.0	1.0	0.11	0.23	14.86	11.02	HGL Too High!
P-142	87.9	0.0	0.0	3.5	0.1	1	0.00	0.12	1.0	1.0	0.12	0.20	14.63	10.52	HGL Too High!
P-143	89.5	17.4	0.0	3.6	0.1	5	0.02	0.16	1.0	0.5	0.08	0.29	14.43	10.28	HGL Too High!
P-170	136.0	64.4	40.7	4.4	0.1	86	0.20	0.38	1.0	0.5	0.19	0.26	14.14	11.16	HGL Too High!
P-171	233.7	0.2	0.3	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	13.88	10.83	HGL Too High!
P-172	241.7	7.2	6.6	4.4	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	13.73	10.55	HGL Too High!
P-173	**297.5**	**5.0**	**2.5**	**4.9**	**0.1**	**0**	**0.00**	**0.23**	**1.0**	**0.5**	**0.12**	**0.23**	**13.57**	**10.22**	**HGL Too High!**
P-174	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.88	10.61	HGL Too High!
P-175	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.88	10.63	HGL Too High!
P-176	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	13.79	10.00	HGL Too High!
P-177	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.06	13.79	10.00	HGL Too High!
P-178	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.57	14.47	10.50	HGL Too High!
P-179	5.3	0.0	0.0	3.9	0.1	56	0.13	0.22	1.3	1.0	0.29	0.33	13.90	9.25	HGL Too High!
P-180	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.10	13.75	10.50	HGL Too High!
P-181	1.2	0.0	0.0	1.8	0.0	45	0.02	0.05	1.3	1.0	0.07	0.08	13.65	9.25	HGL Too High!
P-115	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	16.55	10.00	HGL Too High!
P-116	15.6	0.0	0.0	3.0	0.0	86	0.09	0.18	1.0	0.5	0.09	0.21	16.49	11.99	HGL Too High!
P-117	15.5	0.0	0.0	3.0	0.0	4	0.01	0.10	1.0	1.0	0.10	0.28	16.28	11.71	HGL Too High!
P-118	18.2	0.0	0.0	3.2	0.1	89	0.11	0.21	1.0	1.0	0.21	0.29	16.00	11.30	HGL Too High!
P-113	20.9	9.0	0.0	3.4	0.1	72	0.11	0.31	1.0	1.0	0.31	0.66	15.71	11.30	HGL Too High!
P-114	62.1	0.0	0.0	5.9	0.2	25	0.16	0.50	1.0	1.0	0.50	0.91	15.05	10.75	HGL Too High!
P-110	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.02	15.98	10.00	HGL Too High!
P-111	7.2	0.0	0.0	2.0	0.0	86	0.04	0.08	1.0	0.5	0.04	0.10	15.96	11.99	HGL Too High!
P-112	7.2	0.0	0.0	2.0	0.0	4	0.01	0.05	1.3	1.0	0.06	0.15	15.86	11.71	HGL Too High!
P-120	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.67	7.10	HGL Too High!
P-121	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.04	14.66	7.05	HGL Too High!
P-122	1.6	0.0	0.0	1.1	0.0	7	0.00	0.02	1.3	1.0	0.03	0.08	14.62	7.81	HGL Too High!
P-123	3.6	15.4	0.0	3.0	0.0	81	0.09	0.16	1.0	0.5	0.08	0.11	14.55	8.91	HGL Too High!
P-124	16.0	0.1	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	14.44	9.44	HGL Too High!
P-125	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.44	10.67	HGL Too High!
P-126	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.05	14.60	10.00	HGL Too High!
P-130	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.59	7.10	HGL Too High!
P-131	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.04	14.58	7.15	HGL Too High!
P-132	1.4	0.0	0.0	1.1	0.0	5	0.00	0.02	1.3	1.0	0.02	0.07	14.55	7.81	HGL Too High!
P-133	3.4	8.4	0.0	2.2	0.0	81	0.05	0.09	1.0	0.5	0.04	0.06	14.47	8.91	HGL Too High!
P-134	10.4	0.0	0.0	1.8	0.0	81	0.03	0.07	1.3	1.0	0.09	0.11	14.41	9.44	HGL Too High!
P-135	12.9	19.6	0.0	2.5	0.0	90	0.07	0.13	1.0	0.5	0.07	0.16	14.30	10.15	HGL Too High!
P-136	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.50	10.00	HGL Too High!

Delaware Department of Transportation
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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H + H + H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	15.01	15.01	15	0.4	0.3	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.01	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	14.91	14.91	18	4.2	2.4	7	39	0.0014	0.05	0	0.00	0.02	0.1	8.4	0.0	2.2	0.0	83	0.05	0.10	1.0	0.5	0.05	0.10	15.01	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	14.70	14.70	18	4.8	2.7	89	68	0.0018	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	7	0.01	0.07	1.3	1.0	0.09	0.21	14.91	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	14.43	14.43	18	5.5	3.1	86	25	0.0024	0.06	0	0.00	0.04	12.9	0.0	0.0	2.7	0.0	89	0.08	0.16	1.3	1.0	0.21	0.26	14.70	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	15.01	15.01	18	3.9	2.2	83	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	15.04	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	15.66	15.66	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.66	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	15.60	15.60	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	15.66	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	15.58	15.58	15	1.8	1.4	10	24	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	15.60	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	15.36	15.36	24	11.4	3.6	3	51	0.0022	0.11	0	0.00	0.05	2.6	29.8	0.0	3.1	0.1	89	0.10	0.21	1.0	0.5	0.10	0.21	15.58	10.06	HGL Too High!
P-153	B1	MH-151	1.60	15.58	15.58	24	9.7	3.1	89	17	0.0016	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	15.62	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	15.73	15.73	18	3.9	2.2	89	18	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	15.76	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	15.44	15.44	18	3.4	1.9	90	50	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.05	15.49	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	15.09	15.09	18	8.6	4.9	92	44	0.0057	0.25	0	0.00	0.09	6.5	0.0	6.5	1.9	0.0	90	0.04	0.15	1.3	0.5	0.10	0.35	15.44	10.50	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 50	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-158	DI-158	DI-154	3887	225	4112	0.09	0.91	0.09	0.09	6.0	0.00	4.01	**0.34**	15	100	0.012	0.000024	0.0053	4.2	**5.1**	2.0	0.82	6.82	**4.36**	3.83	Q ok
P-154	DI-154	MH-155	3023	31	3054	0.07	1.00	0.07	0.16	6.0	6.82	7.04	**1.10**	15	24	0.012	0.000246	0.0042	3.7	**4.5**	3.0	0.13	6.95	**3.73**	3.63	Q ok
P-155	MH-155	DI-156	1	0	1	0.00	1.00	0.00	0.72	6.0	6.95	6.98	**5.02**	18	51	0.012	0.001950	0.0039	4.0	**7.1**	4.4	0.19	7.15	3.53	3.33	Q ok
P-156	DI-156	DI-152	2725	0	2725	0.06	1.00	0.06	0.78	6.0	7.15	6.95	**5.44**	18	33	0.012	0.002283	0.0039	4.0	**7.1**	4.5	0.12	7.27	3.23	3.10	Q ok
P-152	DI-152	MH-140	3517	0	3517	0.08	1.00	0.08	2.52	6.0	7.27	6.89	**17.36**	**30**	97	0.012	0.001527	0.0040	5.7	**28.2**	6.0	0.27	7.54	3.00	2.61	Q ok
P-140	MH-140	DI-141	1	0	1	0.00	1.00	0.00	3.79	6.0	7.54	6.83	**25.87**	36	97	0.012	0.001282	0.0040	6.5	**45.8**	6.6	0.24	7.78	2.51	2.12	Q ok
P-141	DI-141	DI-142	3263	65	3328	0.08	1.00	0.08	3.87	6.0	7.78	6.73	**26.03**	36	96	0.012	0.001298	0.0040	6.4	**45.5**	6.6	0.24	8.02	2.02	1.64	Q ok
P-142	DI-142	DI-143	3699	195	3894	0.09	1.00	0.09	3.96	6.0	8.02	6.67	**26.39**	36	68	0.012	0.001333	0.0040	6.4	**45.5**	6.8	0.17	8.19	1.54	1.27	Q ok
P-143	DI-143	MH-170	5428	266	5694	0.13	1.00	0.13	4.93	6.0	8.19	6.61	**32.55**	36	115	0.012	0.002030	0.0040	6.5	**45.7**	7.0	0.27	8.46	1.17	0.71	Q ok
P-170	MH-170	MH-171	1	0	1	0.00	1.00	0.00	8.77	6.0	8.46	6.52	**57.13**	48	55	0.012	0.001348	0.0040	7.8	**98.4**	8.2	0.11	8.58	0.61	0.39	Q ok
P-171	MH-171	MH-172	1	0	1	0.00	1.00	0.00	8.97	6.0	8.58	6.48	**58.16**	48	50	0.012	0.001397	0.0040	7.8	**98.4**	8.2	0.10	8.68	0.29	0.09	Q ok
P-172	MH-172	MH-173	1	0	1	0.00	1.00	0.00	9.99	6.0	8.68	6.45	**64.49**	48	44	0.012	0.001717	0.0041	7.9	**99.5**	8.5	0.09	8.76	-0.01	-0.19	Q ok
P-173	MH-173	OUTFALL	1	0	1	0.00	1.00	0.00	10.64	6.0	8.76	6.42	**68.36**	**48**	64	0.012	0.001930	0.0041	7.9	**99.2**	8.6	0.12	8.89	-0.29	**-0.55**	Q ok
P-174	DI-174	MH-171	3578	530	4108	0.09	1.00	0.09	0.09	6.0	0.00	7.29	**0.69**	18	33	0.012	0.000036	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-175	DI-175	MH-171	4118	530	4648	0.11	1.00	0.11	0.11	6.0	0.00	7.29	**0.78**	18	33	0.012	0.000047	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-176	B4 North	MH-172	22780	0	22780	0.52	1.00	0.52	0.52	6.0	0.00	7.29	**3.81**	18	55	0.012	0.001122	0.0049	4.5	**8.0**	4.5	0.21	6.21	1.26	0.99	Q ok
P-177	B2 South	MH-172	21809	0	21809	0.50	1.00	0.50	0.50	6.0	0.00	7.29	**3.65**	18	55	0.012	0.001029	0.0049	4.5	**8.0**	4.4	0.21	6.21	1.26	0.99	Q ok
P-178	TD-03	DI-179	8687	0	8687	0.20	1.00	0.20	0.20	6.0	0.00	7.29	**1.45**	8	56	0.011	0.010363	0.0509	9.2	**3.2**	9.0	0.10	6.10	8.55	5.70	Q ok
P-179	DI-179	MH-173	6306	3055	9361	0.21	0.84	0.18	0.38	6.0	6.10	7.26	**2.76**	15	30	0.012	0.001550	0.0500	12.8	**15.6**	9.6	0.05	6.16	3.21	1.71	Q ok
P-180	TD-02	DI-181	4084	0	4084	0.09	1.00	0.09	0.09	6.0	0.00	7.29	**0.68**	8	45	0.011	0.002290	0.0500	9.1	**3.2**	6.9	0.11	6.11	8.50	6.25	Q ok
P-181	DI-181	MH-173	6222	2906	9128	0.21	0.85	0.18	0.27	6.0	6.11	7.26	**1.97**	15	30	0.012	0.000790	0.0500	12.8	**15.6**	8.9	0.06	6.17	3.21	1.71	Q ok
P-115	B5 West	MH-116	33468	0	33468	0.77	1.00	0.77	0.77	6.0	0.00	7.29	**5.60**	18	17	0.012	0.002423	0.0047	4.4	**7.8**	4.8	0.06	6.06	3.84	3.76	Q ok
P-116	MH-116	DI-117	1	0	1	0.00	1.00	0.00	0.77	6.0	6.06	7.26	**5.58**	18	60	0.012	0.002402	0.0050	4.6	**8.0**	5.0	0.20	6.26	3.66	3.36	Q ok
P-117	DI-117	DI-118	2919	167	3086	0.07	1.00	0.07	0.84	6.0	6.26	7.20	**6.04**	18	71	0.012	0.002817	0.0051	4.6	**8.1**	5.1	0.23	6.49	3.26	2.90	Q ok
P-118	DI-118	DI-113	2866	196	3062	0.07	1.00	0.07	0.91	6.0	6.49	7.14	**6.49**	18	27	0.012	0.003252	0.0048	4.5	**7.9**	5.0	0.09	6.58	2.80	2.67	Q ok
P-113	DI-113	DI-114	2882	195	3077	0.07	1.00	0.07	1.57	6.0	6.58	7.10	**11.17**	18	41	0.012	0.009634	0.0200	9.1	**16.1**	9.9	0.07	6.65	2.57	1.75	Q ok
P-114	DI-114	MH-170	1592	20	1612	0.04	1.00	0.04	1.61	6.0	6.65	7.07	**11.38**	18	47	0.012	0.010004	0.0200	9.1	**16.1**	9.9	0.08	6.73	1.65	0.71	Q ok
P-110	B4 South	MH-111	22751	0	22751	0.52	1.00	0.52	0.52	6.0	0.00	7.29	**3.81**	18	17	0.012	0.001119	0.0053	4.7	**8.3**	4.5	0.06	6.06	3.61	3.52	Q ok
P-111	MH-111	DI-112	1	0	1	0.00	1.00	0.00	0.52	6.0	6.06	7.26	**3.79**	18	60	0.012	0.001110	0.0050	4.6	**8.0**	4.4	0.23	6.29	3.42	3.12	Q ok
P-112	DI-112	DI-113	2877	164	3041	0.07	1.00	0.07	0.59	6.0	6.29	7.20	**4.26**	18	71	0.012	0.001402	0.0049	4.5	**8.0**	4.6	0.26	6.55	3.02	2.67	Q ok
P-120	DI-120	DI-121	2879	334	3213	0.07	1.00	0.07	0.07	6.0	0.00	7.29	**0.54**	15	22	0.012	0.000059	0.0032	3.2	**3.9**	2.3	0.16	6.16	**3.96**	3.89	Q ok
P-121	DI-121	DI-122	5403	1316	6719	0.15	0.96	0.15	0.22	6.0	6.16	7.23	**1.60**	15	84	0.012	0.000524	0.0031	3.2	**3.9**	2.9	0.48	6.64	3.79	3.53	Q ok
P-122	DI-122	MH-123	4404	1304	5708	0.13	0.93	0.12	0.34	6.0	6.64	7.10	**2.44**	15	56	0.012	0.001215	0.0030	3.1	**3.9**	3.4	0.28	6.92	3.43	3.26	Q ok
P-123	MH-123	DI-124	1	0	1	0.00	1.00	0.00	1.11	6.0	6.92	7.01	**7.76**	**24**	36	0.012	0.001004	0.0036	4.7	**14.7**	4.8	0.13	7.05	3.16	3.03	Q ok
P-124	DI-124	MH-135	3437	323	3760	0.09	1.00	0.09	1.23	6.0	7.05	6.98	**8.59**	**24**	31	0.012	0.001228	0.0048	5.4	**17.0**	5.4	0.10	7.14	2.93	2.78	Q ok
P-125	DI-125	DI-124	1587	15	1602	0.04	1.00	0.04	0.04	6.0	0.00	7.29	**0.27**	15	45	0.012	0.000015	0.0040	3.6	**4.4**	1.8	0.42	6.42	3.21	3.03	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 50	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-126	B5 North	MH-123	33276	0	33276	0.76	1.00	0.76	0.76	6.0	0.00	7.29	**5.57**	18	17	0.012	0.002395	0.0053	4.7	**8.3**	5.0	0.06	6.06	3.36	3.27	Q ok
P-130	DI-130	DI-131	2606	339	2945	0.07	1.00	0.07	0.07	6.0	0.00	7.29	**0.49**	15	22	0.012	0.000050	0.0032	3.2	**3.9**	1.9	0.19	6.19	**3.96**	3.89	Q ok
P-131	DI-131	DI-132	5203	1533	6736	0.15	0.93	0.14	0.21	6.0	6.19	7.23	**1.53**	15	83	0.012	0.000477	0.0030	3.1	**3.8**	2.9	0.48	6.67	3.79	3.54	Q ok
P-132	DI-132	MH-133	4517	1246	5763	0.13	0.94	0.12	0.34	6.0	6.67	7.07	**2.37**	15	56	0.012	0.001152	0.0030	3.1	**3.9**	3.3	0.28	6.95	3.44	3.27	Q ok
P-133	MH-133	DI-134	1	0	1	0.00	1.00	0.00	0.90	6.0	6.95	6.98	**6.28**	24	36	0.012	0.000657	0.0031	4.3	**13.5**	4.2	0.14	7.10	3.17	3.06	Q ok
P-134	DI-134	MH-135	4193	284	4477	0.10	1.00	0.10	1.00	6.0	7.10	6.95	**6.97**	**24**	31	0.012	0.000808	0.0035	4.6	**14.6**	4.6	0.11	7.21	2.96	2.85	Q ok
P-135	MH-135	MH-170	1	0	1	0.00	1.00	0.00	2.23	6.0	7.21	6.92	**15.45**	**30**	94	0.012	0.001209	0.0039	5.7	**27.9**	5.8	0.27	7.48	2.67	2.30	Q ok
P-136	B3 South	MH-133	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	7.29	**4.11**	18	17	0.012	0.001306	0.0047	4.4	**7.8**	4.5	0.06	6.06	3.36	3.28	Q ok
P-144	DI-144	MH-145	2618	65	2683	0.06	1.00	0.06	0.06	6.0	0.00	7.29	**0.45**	15	55	0.012	0.000041	0.0051	4.1	**5.0**	2.4	0.38	6.38	3.79	3.51	Q ok
P-145	MH-145	DI-146	1	0	1	0.00	1.00	0.00	0.63	6.0	6.38	7.17	**4.48**	18	39	0.012	0.001552	0.0049	4.5	**7.9**	4.6	0.14	6.52	3.41	3.22	Q ok
P-146	DI-146	DI-147	3675	195	3870	0.09	1.00	0.09	0.71	6.0	6.52	7.14	**5.10**	18	68	0.012	0.002007	0.0050	4.6	**8.0**	4.9	0.23	6.75	3.12	2.78	Q ok
P-147	DI-147	DI-143	5191	266	5457	0.13	1.00	0.13	0.84	6.0	6.75	7.07	**5.94**	18	25	0.012	0.002724	0.0052	4.6	**8.2**	5.1	0.08	6.83	2.68	2.55	Q ok
P-148	B3 West	MH-145	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	7.29	**4.11**	18	17	0.012	0.001306	0.0053	4.7	**8.3**	4.6	0.06	6.06	3.60	3.51	Q ok
P-167	DI-167	DI-159	3909	227	4136	0.09	0.91	0.09	0.09	6.0	6.00	4.01	**0.35**	15	18	0.012	0.000024	0.0033	3.3	**4.0**	2.0	0.15	6.15	4.29	4.23	Q ok
P-159	DI-159	DI-150	3909	227	4136	0.09	0.91	0.09	0.17	6.0	6.15	3.98	**0.69**	15	100	0.012	0.000096	0.0053	4.2	**5.1**	2.9	0.57	6.73	4.13	3.60	Q ok
P-150	DI-150	MH-151	3037	0	3037	0.07	1.00	0.07	0.24	6.0	0.00	7.29	**1.76**	15	24	0.012	0.000636	0.0042	3.7	**4.5**	3.4	0.12	6.12	3.50	3.40	Q ok
P-151	MH-151	DI-152	1	0	1	0.00	1.00	0.00	1.66	6.0	6.12	7.26	**12.03**	24	51	0.012	0.002411	0.0039	4.9	**15.3**	5.5	0.16	6.27	3.30	3.10	Q ok
P-153	B1	MH-151	61668	0	61668	1.42	1.00	1.42	1.42	6.0	0.00	7.29	**10.32**	24	17	0.012	0.001773	0.0100	7.8	**24.5**	7.2	0.04	6.04	3.57	3.40	Q ok
P-157	B3 North	MH-155	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	7.29	**4.11**	18	18	0.012	0.001306	0.0050	4.6	**8.0**	4.5	0.07	6.07	3.72	3.63	Q ok
P-166	B2 North	MH-163	21657	0	21657	0.50	1.00	0.50	0.50	6.0	0.00	7.29	**3.62**	18	50	0.012	0.001014	0.0050	4.6	**8.0**	4.4	0.19	6.19	3.62	3.37	Q ok
P-163	MH-163	MH-140	1	0	1	0.00	1.00	0.00	1.27	6.0	6.19	7.23	**9.17**	18	44	0.012	0.006497	0.0150	7.9	**13.9**	8.4	0.09	6.28	3.27	2.61	Q ok

KEY	
	Upsized from Semi-Final Design to have capacity for 50-yr design storm
	Optional Upsize-50-yr design storm results in >85% Full
	No Change from Semi-Final Design

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H=H_f+H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	5.94	5.94	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.96	7.70	HGL ok
P-154	DI-154	MH-155	1.00	5.93	5.93	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.94	9.06	HGL ok
P-155	MH-155	DI-156	1.20	5.77	5.77	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	0.5	0.06	0.17	5.93	10.06	HGL ok
P-156	DI-156	DI-152	1.20	5.51	5.51	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	5.77	11.07	HGL ok
P-152	DI-152	MH-140	2.00	5.20	5.20	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	5.51	11.07	HGL ok
P-140	MH-140	DI-141	2.40	4.94	4.94	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	0.5	0.13	0.26	5.20	12.04	HGL ok
P-141	DI-141	DI-142	2.40	4.68	4.68	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	4.94	11.02	HGL ok
P-142	DI-142	DI-143	2.40	4.46	4.46	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	4.68	10.52	HGL ok
P-143	DI-143	MH-170	2.40	4.12	4.12	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	0.5	0.09	0.34	4.46	10.28	HGL ok
P-170	MH-170	MH-171	3.20	3.83	3.83	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	0.5	0.22	0.29	4.12	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.65	3.65	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	3.83	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.46	3.46	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	0.5	0.11	0.19	3.65	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.20**	**3.20**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	**0.5**	**0.13**	**0.26**	**3.46**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	3.83	3.83	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.83	10.61	HGL ok
P-175	DI-175	MH-171	1.20	3.83	3.83	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.83	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.65	3.65	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	3.72	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.65	3.65	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	3.72	10.00	HGL ok
P-178	TD-03	DI-179	0.53	3.84	6.23	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	6.88	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.46	3.46	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	1.3	1.0	0.33	0.38	3.84	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.56	6.78	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	6.90	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.46	3.46	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	1.3	1.0	0.08	0.10	3.56	9.25	HGL ok
P-115	B5 West	MH-116	1.20	6.80	6.80	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	6.86	10.00	HGL ok
P-116	MH-116	DI-117	1.20	6.55	6.55	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	0.5	0.10	0.24	6.80	11.99	HGL ok
P-117	DI-117	DI-118	1.20	6.24	6.24	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	6.55	11.71	HGL ok
P-118	DI-118	DI-113	1.20	5.91	5.91	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	6.24	11.30	HGL ok
P-113	DI-113	DI-114	1.20	5.15	5.15	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	5.91	11.30	HGL ok
P-114	DI-114	MH-170	1.20	4.12	4.12	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	5.15	10.75	HGL ok
P-110	B4 South	MH-111	1.20	6.19	6.19	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	6.22	10.00	HGL ok
P-111	MH-111	DI-112	1.20	6.08	6.08	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	0.5	0.05	0.11	6.19	11.99	HGL ok
P-112	DI-112	DI-113	1.20	5.91	5.91	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	1.3	1.0	0.07	0.17	6.08	11.71	HGL ok
P-120	DI-120	DI-121	1.00	4.94	4.94	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.94	7.10	HGL ok
P-121	DI-121	DI-122	1.00	4.89	4.89	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.05	4.94	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.78	4.78	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	4.89	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.66	4.66	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	0.5	0.09	0.13	4.78	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.49	4.49	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	4.66	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.66	4.66	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.66	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.78	4.78	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	4.84	10.00	HGL ok
P-130	DI-130	DI-131	1.00	4.88	4.89	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.83	4.83	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.05	4.88	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.73	4.73	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	1.3	1.0	0.03	0.10	4.83	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.60	4.66	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	0.5	0.05	0.07	4.73	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.49	4.49	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	4.60	9.44	HGL ok
P-135	MH-135	MH-170	2.00	4.12	4.30	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	0.5	0.08	0.19	4.49	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.73	4.73	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	4.77	10.00	HGL ok

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	5.11	5.11	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.11	11.02	HGL ok
P-145	MH-145	DI-146	1.20	4.99	4.99	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	5.11	10.87	HGL ok
P-146	DI-146	DI-147	1.20	4.76	4.76	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	4.99	10.52	HGL ok
P-147	DI-147	DI-143	1.20	4.46	4.46	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	4.76	10.28	HGL ok
P-148	B3 West	MH-145	1.20	5.11	5.11	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	5.14	10.00	HGL ok
P-167	DI-167	DI-159	1.00	5.84	5.84	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.85	7.48	HGL ok
P-159	DI-159	DI-150	1.00	5.78	5.78	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	5.84	7.70	HGL ok
P-150	DI-150	MH-151	1.00	5.76	5.76	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	5.78	9.06	HGL ok
P-151	MH-151	DI-152	1.60	5.51	5.51	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	5.76	10.06	HGL ok
P-153	B1	MH-151	1.60	5.76	5.76	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	5.81	10.00	HGL ok
P-157	B3 North	MH-155	1.20	5.93	5.93	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	5.97	10.00	HGL ok
P-166	B2 North	MH-163	1.20	5.60	5.60	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	5.66	10.00	HGL ok
P-163	MH-163	MH-140	1.20	5.20	5.20	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	5.60	10.50	HGL ok

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D — 0.8D (ft)	Tailwater, link to Inlet WSE of downstream pipe — TW (ft)	Outlet W. S. Elevation — HGL Dn (ft)	Outflow Pipe Diameter — D_o (in)	Outflow Pipe Design Flow — Q_o (cfs)	Pressure-flow Vel., $V_o=Q_o/A$ — V_o (fps)	Skew angle vs. — Δ_o (deg)	Outflow Pipe Length — L (ft)	Friction Slope — S_{fo} (ft/ft)	Friction Loss — H_f (ft)	Angle of Curvat — O (deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ — H_c (ft)	Contraction Loss — H_o (ft)	Q*V for determining controlling inflow pipe — Q1V1 (ft^4/s^2)	Q*V for determining controlling inflow pipe — Q2V2 (ft^4/s^2)	Q*V for determining controlling inflow pipe — Q3V3 (ft^4/s^2)	Controlling Inflow Velocity — Vi	Expansion Loss — Hi (ft)	Controlling In-flow skew — Δ_i (deg)	Bend Loss — H_Δ (ft)	Total Jct. Loss — H_t (cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss — $H_{t\ adj}$ (ft)	Tot. H Loss, $H = H_f + H_{t\ adj}$ — H (ft)	Inlet W. S. Elevation — HGL Up (ft)	Top of Grate — T/G (ft)	HGL Check
P-158	DI-158	DI-154	1.00	6.14	6.14	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.16	7.70	HGL ok
P-154	DI-154	MH-155	1.00	6.13	6.13	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.14	9.06	HGL ok
P-155	MH-155	DI-156	1.20	5.97	5.97	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	*0.5*	0.06	0.17	6.13	10.06	HGL ok
P-156	DI-156	DI-152	1.20	5.71	5.71	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	5.97	11.07	HGL ok
P-152	DI-152	MH-140	2.00	5.40	5.40	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	5.71	11.07	HGL ok
P-140	MH-140	DI-141	2.40	5.14	5.14	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	*0.5*	0.13	0.26	5.40	12.04	HGL ok
P-141	DI-141	DI-142	2.40	4.88	4.88	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	5.14	11.02	HGL ok
P-142	DI-142	DI-143	2.40	4.66	4.66	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	4.88	10.52	HGL ok
P-143	DI-143	MH-170	2.40	4.32	4.32	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	*0.5*	0.09	0.34	4.66	10.28	HGL ok
P-170	MH-170	MH-171	3.20	4.03	4.03	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	*0.5*	0.22	0.29	4.32	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.85	3.85	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	*0.5*	0.10	0.17	4.03	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.66	3.66	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.19	3.85	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.40**	**3.40**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	***0.5***	**0.13**	**0.26**	**3.66**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	4.03	4.03	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.03	10.61	HGL ok
P-175	DI-175	MH-171	1.20	4.03	4.03	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.03	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.85	3.85	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	3.92	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.85	3.85	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.06	3.92	10.00	HGL ok
P-178	TD-03	DI-179	0.53	4.04	6.23	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	6.88	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.66	3.66	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	*1.3*	1.0	0.33	0.38	4.04	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.76	6.78	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	6.90	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.66	3.66	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	*1.3*	1.0	0.08	0.10	3.76	9.25	HGL ok
P-115	B5 West	MH-116	1.20	7.00	7.00	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.06	7.06	10.00	HGL ok
P-116	MH-116	DI-117	1.20	6.75	6.75	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	*0.5*	0.10	0.24	7.00	11.99	HGL ok
P-117	DI-117	DI-118	1.20	6.44	6.44	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	6.75	11.71	HGL ok
P-118	DI-118	DI-113	1.20	6.11	6.11	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	6.44	11.30	HGL ok
P-113	DI-113	DI-114	1.20	5.35	5.35	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	6.11	11.30	HGL ok
P-114	DI-114	MH-170	1.20	4.32	4.32	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	5.35	10.75	HGL ok
P-110	B4 South	MH-111	1.20	6.39	6.39	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	6.42	10.00	HGL ok
P-111	MH-111	DI-112	1.20	6.28	6.28	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	*0.5*	0.05	0.11	6.39	11.99	HGL ok
P-112	DI-112	DI-113	1.20	6.11	6.11	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	*1.3*	1.0	0.07	0.17	6.28	11.71	HGL ok
P-120	DI-120	DI-121	1.00	4.96	4.96	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.96	7.10	HGL ok
P-121	DI-121	DI-122	1.00	4.91	4.91	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.05	4.96	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.80	4.80	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.10	4.91	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.68	4.68	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	*0.5*	0.09	0.13	4.80	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.51	4.51	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	4.68	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.68	4.68	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.68	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.80	4.80	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.06	4.86	10.00	HGL ok
P-130	DI-130	DI-131	1.00	4.88	4.89	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.83	4.83	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.05	4.88	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.73	4.73	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	*1.3*	1.0	0.03	0.10	4.83	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.62	4.66	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	*0.5*	0.05	0.07	4.73	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.51	4.51	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	4.62	9.44	HGL ok
P-135	MH-135	MH-170	2.00	4.32	4.32	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	*0.5*	0.08	0.19	4.51	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.73	4.73	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	4.77	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	5.31	5.31	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.31	11.02	HGL ok
P-145	MH-145	DI-146	1.20	5.19	5.19	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	5.31	10.87	HGL ok
P-146	DI-146	DI-147	1.20	4.96	4.96	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	5.19	10.52	HGL ok
P-147	DI-147	DI-143	1.20	4.66	4.66	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	4.96	10.28	HGL ok
P-148	B3 West	MH-145	1.20	5.31	5.31	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	5.34	10.00	HGL ok
P-167	DI-167	DI-159	1.00	6.04	6.04	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.05	7.48	HGL ok
P-159	DI-159	DI-150	1.00	5.98	5.98	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	6.04	7.70	HGL ok
P-150	DI-150	MH-151	1.00	5.96	5.96	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	5.98	9.06	HGL ok
P-151	MH-151	DI-152	1.60	5.71	5.71	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	5.96	10.06	HGL ok
P-153	B1	MH-151	1.60	5.96	5.96	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	6.01	10.00	HGL ok
P-157	B3 North	MH-155	1.20	6.13	6.13	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	6.17	10.00	HGL ok
P-166	B2 North	MH-163	1.20	5.80	5.80	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	5.86	10.00	HGL ok
P-163	MH-163	MH-140	1.20	5.40	5.40	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	5.80	10.50	HGL ok

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Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Hi= H_Δ +H_t +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	9.64	9.64	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.66	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.63	9.63	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.64	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.47	9.47	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	0.5	0.06	0.17	9.63	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	9.21	9.21	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	9.47	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.90	8.90	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	9.21	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.64	8.64	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	0.5	0.13	0.26	8.90	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.38	8.38	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	8.64	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.16	8.16	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	8.38	10.52	HGL ok
P-143	DI-143	MH-170	2.40	7.82	7.82	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	0.5	0.09	0.34	8.16	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.53	7.53	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	0.5	0.22	0.29	7.82	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.35	7.35	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	7.53	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.16	7.16	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	0.5	0.11	0.19	7.35	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	**0.5**	**0.13**	**0.26**	**7.16**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.53	7.53	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.53	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.53	7.53	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.53	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.35	7.35	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	7.42	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.35	7.35	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	7.42	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.54	7.54	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	8.19	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.16	7.16	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	1.3	1.0	0.33	0.38	7.54	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.26	7.26	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	7.38	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.16	7.16	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	1.3	1.0	0.08	0.10	7.26	9.25	HGL ok
P-115	B5 West	MH-116	1.20	10.50	10.50	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	10.56	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.25	10.25	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	0.5	0.10	0.24	10.50	11.99	HGL ok
P-117	DI-117	DI-118	1.20	9.94	9.94	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	10.25	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.61	9.61	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	9.94	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.85	8.85	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	9.61	11.30	HGL ok
P-114	DI-114	MH-170	1.20	7.82	7.82	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	8.85	10.75	HGL ok
P-110	B4 South	MH-111	1.20	9.89	9.89	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.92	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.78	9.78	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	0.5	0.05	0.11	9.89	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.61	9.61	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	1.3	1.0	0.07	0.17	9.78	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.46	8.46	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.46	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.41	8.41	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.05	8.46	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.30	8.30	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	8.41	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.18	8.18	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	0.5	0.09	0.13	8.30	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.01	8.01	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	8.18	9.44	HGL ok
P-125	DI-125	DI-124	1.00	8.18	8.18	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.18	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.30	8.30	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	8.36	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.34	8.34	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.34	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.29	8.29	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.05	8.34	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.19	8.19	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	1.3	1.0	0.03	0.10	8.29	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.12	8.12	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	0.5	0.05	0.07	8.19	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.01	8.01	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	8.12	9.44	HGL ok
P-135	MH-135	MH-170	2.00	7.82	7.82	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	0.5	0.08	0.19	8.01	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.19	8.19	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.23	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.81	8.81	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.81	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.69	8.69	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	8.81	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.46	8.46	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	8.69	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.16	8.16	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	8.46	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.81	8.81	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.84	10.00	HGL ok
P-167	DI-167	DI-159	1.00	9.54	9.54	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.55	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.48	9.48	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	9.54	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.46	9.46	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	9.48	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	9.21	9.21	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	9.46	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.46	9.46	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	9.51	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	9.63	9.63	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.67	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.30	9.30	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	9.36	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	8.90	8.90	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	9.30	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 50 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss $H_{t\ adj}$ ft	Tot. H Loss, $H=H_f+H_{t\ adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	10.14	10.14	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.16	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.13	10.13	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.14	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.97	9.97	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	0.5	0.06	0.17	10.13	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	9.71	9.71	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	9.97	11.07	HGL ok
P-152	DI-152	MH-140	2.00	9.40	9.40	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	9.71	11.07	HGL ok
P-140	MH-140	DI-141	2.40	9.14	9.14	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	0.5	0.13	0.26	9.40	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.88	8.88	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	9.14	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.66	8.66	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	8.88	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.32	8.32	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	0.5	0.09	0.34	8.66	10.28	HGL ok
P-170	MH-170	MH-171	3.20	8.03	8.03	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	0.5	0.22	0.29	8.32	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.85	7.85	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	8.03	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.66	7.66	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	0.5	0.11	0.19	7.85	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	**0.5**	**0.13**	**0.26**	**7.66**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.03	8.03	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.03	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.03	8.03	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.03	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.85	7.85	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	7.92	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.85	7.85	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	7.92	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.04	8.04	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	8.69	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.66	7.66	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	1.3	1.0	0.33	0.38	8.04	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.76	7.76	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	7.88	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.66	7.66	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	1.3	1.0	0.08	0.10	7.76	9.25	HGL ok
P-115	B5 West	MH-116	1.20	11.00	11.00	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	11.06	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.75	10.75	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	0.5	0.10	0.24	11.00	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	10.44	10.44	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	10.75	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	10.11	10.11	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	10.44	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	9.35	9.35	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	10.11	11.30	HGL ok
P-114	DI-114	MH-170	1.20	8.32	8.32	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	9.35	10.75	HGL ok
P-110	B4 South	MH-111	1.20	10.39	10.39	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.42	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.28	10.28	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	0.5	0.05	0.11	10.39	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.11	10.11	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	1.3	1.0	0.07	0.17	10.28	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.96	8.96	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.96	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.91	8.91	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.05	8.96	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.80	8.80	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	8.91	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.68	8.68	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	0.5	0.09	0.13	8.80	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.51	8.51	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	8.68	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	8.68	8.68	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.68	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.80	8.80	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	8.86	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.84	8.84	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.84	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.79	8.79	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.05	8.84	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.69	8.69	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	1.3	1.0	0.03	0.10	8.79	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.62	8.62	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	0.5	0.05	0.07	8.69	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.51	8.51	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	8.62	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.32	8.32	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	0.5	0.08	0.19	8.51	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.69	8.69	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.73	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.31	9.31	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.31	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.19	9.19	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	9.31	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.96	8.96	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	9.19	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.66	8.66	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	8.96	10.28	HGL ok
P-148	B3 West	MH-145	1.20	9.31	9.31	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.34	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.04	10.04	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.05	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.98	9.98	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.04	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.96	9.96	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	9.98	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	9.71	9.71	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	9.96	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.96	9.96	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	10.01	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.13	10.13	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.17	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.80	9.80	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	9.86	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.40	9.40	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	9.80	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	10.54	10.54	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.56	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.53	10.53	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.54	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.37	10.37	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	*0.5*	0.06	0.17	10.53	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.11	10.11	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	10.37	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	9.80	9.80	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	10.11	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	9.54	9.54	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	*0.5*	0.13	0.26	9.80	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.28	9.28	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	9.54	11.02	HGL ok
P-142	DI-142	DI-143	2.40	9.06	9.06	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	9.28	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.72	8.72	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	*0.5*	0.09	0.34	9.06	10.28	HGL ok
P-170	MH-170	MH-171	3.20	8.43	8.43	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	*0.5*	0.22	0.29	8.72	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.25	8.25	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	*0.5*	0.10	0.17	8.43	10.83	HGL ok
P-172	MH-172	MH-173	3.20	8.06	8.06	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.19	8.25	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	***0.5***	**0.13**	**0.26**	**8.06**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.43	8.43	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.43	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.43	8.43	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.43	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.25	8.25	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	8.32	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.25	8.25	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.06	8.32	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.44	8.44	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	9.09	10.50	HGL ok
P-179	DI-179	MH-173	1.00	8.06	8.06	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	*1.3*	1.0	0.33	0.38	8.44	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	8.16	8.16	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	8.28	10.50	HGL ok
P-181	DI-181	MH-173	1.00	8.06	8.06	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	*1.3*	1.0	0.08	0.10	8.16	9.25	HGL ok
P-115	B5 West	MH-116	1.20	11.40	11.40	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.06	11.46	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.15	11.15	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	*0.5*	0.10	0.24	11.40	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	10.84	10.84	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	11.15	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	10.51	10.51	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	10.84	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	9.75	9.75	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	10.51	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	8.72	8.72	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	9.75	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	10.79	10.79	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	10.82	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.68	10.68	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	*0.5*	0.05	0.11	10.79	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.51	10.51	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	*1.3*	1.0	0.07	0.17	10.68	11.71	HGL ok
P-120	DI-120	DI-121	1.00	9.36	9.36	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.36	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.31	9.31	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.05	9.36	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.20	9.20	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.10	9.31	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.08	9.08	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	*0.5*	0.09	0.13	9.20	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.91	8.91	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	9.08	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.08	9.08	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.08	10.67	HGL ok
P-126	B5 North	MH-123	1.20	9.20	9.20	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.06	9.26	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.24	9.24	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.24	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.19	9.19	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.05	9.24	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.09	9.09	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	*1.3*	1.0	0.03	0.10	9.19	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.02	9.02	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	*0.5*	0.05	0.07	9.09	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.91	8.91	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	9.02	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.72	8.72	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	*0.5*	0.08	0.19	8.91	10.15	HGL ok
P-136	B3 South	MH-133	1.20	9.09	9.09	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	9.13	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.71	9.71	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.71	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.59	9.59	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	9.71	10.87	HGL ok
P-146	DI-146	DI-147	1.20	9.36	9.36	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	9.59	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.06	9.06	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	9.36	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	9.71	9.71	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.74	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.44	10.44	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.45	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.38	10.38	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.44	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.36	10.36	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.38	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.11	10.11	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	10.36	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.36	10.36	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	10.41	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.53	10.53	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.57	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.20	10.20	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	10.26	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.80	9.80	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	10.20	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	11.04	11.04	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.06	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.03	11.03	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.04	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.87	10.87	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	0.5	0.06	0.17	11.03	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.61	10.61	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	10.87	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.30	10.30	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	10.61	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.04	10.04	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	0.5	0.13	0.26	10.30	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.78	9.78	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	10.04	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	9.56	9.56	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	9.78	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.22	9.22	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	0.5	0.09	0.34	9.56	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	8.93	8.93	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	0.5	0.22	0.29	9.22	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.75	8.75	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	8.93	10.83	HGL ok
P-172	MH-172	MH-173	3.20	8.56	8.56	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	0.5	0.11	0.19	8.75	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	**0.5**	**0.13**	**0.26**	**8.56**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.93	8.93	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.93	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.93	8.93	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.93	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.75	8.75	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	8.82	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.75	8.75	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	8.82	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.94	8.94	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	9.59	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	8.56	8.56	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	1.3	1.0	0.33	0.38	8.94	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	8.66	8.66	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	8.78	10.50	HGL ok
P-181	DI-181	MH-173	1.00	8.56	8.56	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	1.3	1.0	0.08	0.10	8.66	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	11.90	11.90	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	11.96	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.65	11.65	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	0.5	0.10	0.24	11.90	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.34	11.34	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	11.65	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.01	11.01	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	11.34	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.25	10.25	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	11.01	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	9.22	9.22	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	10.25	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.29	11.29	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.32	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.18	11.18	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	0.5	0.05	0.11	11.29	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.01	11.01	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	1.3	1.0	0.07	0.17	11.18	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	9.86	9.86	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.86	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.81	9.81	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.05	9.86	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.70	9.70	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	9.81	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.58	9.58	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	0.5	0.09	0.13	9.70	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.41	9.41	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	9.58	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.58	9.58	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.58	10.67	HGL ok
P-126	B5 North	MH-123	1.20	9.70	9.70	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	9.76	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.74	9.74	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.74	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.69	9.69	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.05	9.74	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.59	9.59	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	1.3	1.0	0.03	0.10	9.69	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.52	9.52	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	0.5	0.05	0.07	9.59	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.41	9.41	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	9.52	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.22	9.22	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	0.5	0.08	0.19	9.41	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	9.59	9.59	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.63	10.00	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V$_o$^{2}/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H$_f$ +H$_i$ +H$_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H$_f$ + H$_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.21	10.21	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.21	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.09	10.09	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	10.21	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	9.86	9.86	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	10.09	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.56	9.56	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	9.86	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.21	10.21	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.24	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.94	10.94	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.95	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.88	10.88	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.94	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.86	10.86	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.88	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.61	10.61	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	10.86	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.86	10.86	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	10.91	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.03	11.03	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.07	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.70	10.70	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	10.76	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.30	10.30	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	10.70	10.50	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	11.74	11.74	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.76	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.73	11.73	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.74	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.57	11.57	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	*0.5*	0.06	0.17	11.73	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.31	11.31	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	11.57	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.00	11.00	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	11.31	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.74	10.74	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	*0.5*	0.13	0.26	11.00	12.04	HGL ok
P-141	DI-141	DI-142	2.40	10.48	10.48	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	10.74	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.26	10.26	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	10.48	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.92	9.92	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	*0.5*	0.09	0.34	10.26	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.63	9.63	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	*0.5*	0.22	0.29	9.92	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.45	9.45	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	*0.5*	0.10	0.17	9.63	10.83	HGL ok
P-172	MH-172	MH-173	3.20	9.26	9.26	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.19	9.45	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	***0.5***	**0.13**	**0.26**	**9.26**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	9.63	9.63	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.63	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	9.63	9.63	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.63	10.63	HGL ok
P-176	B4 North	MH-172	1.20	9.45	9.45	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	9.52	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.45	9.45	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.06	9.52	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.64	9.64	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	10.29	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.26	9.26	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	*1.3*	1.0	0.33	0.38	9.64	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.36	9.36	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	9.48	10.50	HGL ok
P-181	DI-181	MH-173	1.00	9.26	9.26	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	*1.3*	1.0	0.08	0.10	9.36	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.60	12.60	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.06	12.66	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.35	12.35	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	*0.5*	0.10	0.24	12.60	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.04	12.04	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	12.35	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.71	11.71	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	12.04	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.95	10.95	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	11.71	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	9.92	9.92	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	10.95	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.99	11.99	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	12.02	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.88	11.88	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	*0.5*	0.05	0.11	11.99	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.71	11.71	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	*1.3*	1.0	0.07	0.17	11.88	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.56	10.56	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.56	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.51	10.51	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.05	10.56	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.40	10.40	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.10	10.51	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.28	10.28	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	*0.5*	0.09	0.13	10.40	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.11	10.11	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	10.28	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.28	10.28	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.28	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.40	10.40	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.06	10.46	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.44	10.44	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.44	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.39	10.39	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.05	10.44	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.29	10.29	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	*1.3*	1.0	0.03	0.10	10.39	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.22	10.22	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	*0.5*	0.05	0.07	10.29	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.11	10.11	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	10.22	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.92	9.92	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	*0.5*	0.08	0.19	10.11	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.29	10.29	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	10.33	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.91	10.91	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.91	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.79	10.79	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	10.91	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.56	10.56	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	10.79	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.26	10.26	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	10.56	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.91	10.91	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.94	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.64	11.64	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.65	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.58	11.58	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.64	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.56	11.56	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.58	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.31	11.31	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	11.56	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.56	11.56	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	11.61	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.73	11.73	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.77	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.40	11.40	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	11.46	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.00	11.00	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	11.40	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 50 -year (50-year for sumps)

No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
			0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.24	12.24	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.26	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.23	12.23	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.24	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.07	12.07	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	0.5	0.06	0.17	12.23	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.81	11.81	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	12.07	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.50	11.50	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	11.81	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.24	11.24	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	0.5	0.13	0.26	11.50	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	10.98	10.98	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	11.24	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.76	10.76	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	10.98	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.42	10.42	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	0.5	0.09	0.34	10.76	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.13	10.13	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	0.5	0.22	0.29	10.42	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	9.95	9.95	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	10.13	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.76	9.76	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	0.5	0.11	0.19	9.95	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	**0.5**	**0.13**	**0.26**	**9.76**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.13	10.13	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.13	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.13	10.13	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.13	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.95	9.95	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	10.02	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.95	9.95	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	10.02	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.14	10.14	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	10.79	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.76	9.76	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	1.3	1.0	0.33	0.38	10.14	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.86	9.86	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	9.98	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.76	9.76	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	1.3	1.0	0.08	0.10	9.86	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.10	13.10	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	13.16	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.85	12.85	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	0.5	0.10	0.24	13.10	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.54	12.54	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	12.85	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.21	12.21	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	12.54	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.45	11.45	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	12.21	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.42	10.42	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	11.45	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.49	12.49	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.52	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.38	12.38	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	0.5	0.05	0.11	12.49	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.21	12.21	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	1.3	1.0	0.07	0.17	12.38	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.06	11.06	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.06	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.01	11.01	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.05	11.06	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.90	10.90	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	11.01	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.78	10.78	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	0.5	0.09	0.13	10.90	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.61	10.61	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	10.78	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.78	10.78	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.78	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.90	10.90	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	10.96	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.94	10.94	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.94	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.89	10.89	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.05	10.94	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.79	10.79	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	1.3	1.0	0.03	0.10	10.89	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.72	10.72	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	0.5	0.05	0.07	10.79	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.61	10.61	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	10.72	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.42	10.42	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	0.5	0.08	0.19	10.61	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.79	10.79	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.83	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.41	11.41	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.41	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.29	11.29	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	11.41	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.06	11.06	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	11.29	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.76	10.76	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	11.06	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.41	11.41	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.44	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.14	12.14	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.15	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.08	12.08	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.14	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.06	12.06	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.08	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.81	11.81	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	12.06	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.06	12.06	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	12.11	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.23	12.23	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.27	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.90	11.90	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	11.96	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.50	11.50	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	11.90	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	13.54	13.54	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.56	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.53	13.53	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.54	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.37	13.37	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	0.5	0.06	0.17	13.53	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.11	13.11	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	13.37	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.80	12.80	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	13.11	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.54	12.54	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	0.5	0.13	0.26	12.80	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.28	12.28	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	12.54	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.06	12.06	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	12.28	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.72	11.72	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	0.5	0.09	0.34	12.06	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.43	11.43	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	0.5	0.22	0.29	11.72	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.25	11.25	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	11.43	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.06	11.06	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	0.5	0.11	0.19	11.25	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	0.5	**0.13**	**0.26**	**11.06**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.43	11.43	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.43	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.43	11.43	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.43	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.25	11.25	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	11.32	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.25	11.25	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	11.32	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.44	11.44	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	12.09	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.06	11.06	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	1.3	1.0	0.33	0.38	11.44	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.16	11.16	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	11.28	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.06	11.06	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	1.3	1.0	0.08	0.10	11.16	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.40	14.40	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	14.46	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.15	14.15	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	0.5	0.10	0.24	14.40	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.84	13.84	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	14.15	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.51	13.51	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	13.84	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.75	12.75	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	13.51	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.72	11.72	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	12.75	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.79	13.79	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.82	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.68	13.68	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	0.5	0.05	0.11	13.79	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.51	13.51	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	1.3	1.0	0.07	0.17	13.68	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.36	12.36	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.36	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.31	12.31	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.05	12.36	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.20	12.20	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	12.31	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.08	12.08	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	0.5	0.09	0.13	12.20	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.91	11.91	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	12.08	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.08	12.08	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.08	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.20	12.20	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	12.26	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.24	12.24	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.24	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.19	12.19	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.05	12.24	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.09	12.09	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	1.3	1.0	0.03	0.10	12.19	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.02	12.02	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	0.5	0.05	0.07	12.09	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.91	11.91	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	12.02	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.72	11.72	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	0.5	0.08	0.19	11.91	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.09	12.09	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.13	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V$_o$^{2}/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H$_f$ +H$_i$ +H$_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H$_f$ + H$_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.71	12.71	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.71	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.59	12.59	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	12.71	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.36	12.36	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	12.59	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.06	12.06	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	12.36	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.71	12.71	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.74	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.44	13.44	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.45	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.38	13.38	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.44	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.36	13.36	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.38	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.11	13.11	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	13.36	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.36	13.36	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	13.41	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.53	13.53	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.57	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.20	13.20	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	13.26	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.80	12.80	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	13.20	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 50 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	8.48	8.48	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.50	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	8.47	8.47	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.48	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	8.31	8.31	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	0.5	0.06	0.17	8.47	10.06	HGL ok
P-156	DI-156	DI-152	1.20	8.05	8.05	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	8.31	11.07	HGL ok
P-152	DI-152	MH-140	2.00	7.74	7.74	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	8.05	11.07	HGL ok
P-140	MH-140	DI-141	2.40	7.48	7.48	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	0.5	0.13	0.26	7.74	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.22	7.22	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	7.48	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.00	7.00	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	7.22	10.52	HGL ok
P-143	DI-143	MH-170	2.40	6.66	6.66	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	0.5	0.09	0.34	7.00	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.37	6.37	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	0.5	0.22	0.29	6.66	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.19	6.19	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	6.37	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.00	6.00	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	0.5	0.11	0.19	6.19	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	**0.5**	**0.13**	**0.26**	**6.00**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.37	6.37	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.37	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.37	6.37	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.37	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.19	6.19	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	6.26	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.19	6.19	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	6.26	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.38	6.38	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	7.03	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.00	6.00	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	1.3	1.0	0.33	0.38	6.38	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.10	6.78	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	6.90	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.00	6.00	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	1.3	1.0	0.08	0.10	6.10	9.25	HGL ok
P-115	B5 West	MH-116	1.20	9.34	9.34	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	9.40	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.09	9.09	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	0.5	0.10	0.24	9.34	11.99	HGL ok
P-117	DI-117	DI-118	1.20	8.78	8.78	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	9.09	11.71	HGL ok
P-118	DI-118	DI-113	1.20	8.45	8.45	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	8.78	11.30	HGL ok
P-113	DI-113	DI-114	1.20	7.69	7.69	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	8.45	11.30	HGL ok
P-114	DI-114	MH-170	1.20	6.66	6.66	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	7.69	10.75	HGL ok
P-110	B4 South	MH-111	1.20	8.73	8.73	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.76	10.00	HGL ok
P-111	MH-111	DI-112	1.20	8.62	8.62	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	0.5	0.05	0.11	8.73	11.99	HGL ok
P-112	DI-112	DI-113	1.20	8.45	8.45	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	1.3	1.0	0.07	0.17	8.62	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.30	7.30	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.30	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.25	7.25	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.05	7.30	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.14	7.14	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	7.25	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.02	7.02	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	0.5	0.09	0.13	7.14	8.91	HGL ok
P-124	DI-124	MH-135	1.60	6.85	6.85	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	7.02	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.02	7.02	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.02	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.14	7.14	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	7.20	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.18	7.18	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.18	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.13	7.13	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.05	7.18	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.03	7.03	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	1.3	1.0	0.03	0.10	7.13	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	6.96	6.96	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	0.5	0.05	0.07	7.03	8.91	HGL ok
P-134	DI-134	MH-135	1.60	6.85	6.85	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	6.96	9.44	HGL ok
P-135	MH-135	MH-170	2.00	6.66	6.66	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	0.5	0.08	0.19	6.85	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.03	7.03	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	7.07	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	7.65	7.65	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.65	11.02	HGL ok
P-145	MH-145	DI-146	1.20	7.53	7.53	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	7.65	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.30	7.30	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	7.53	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.00	7.00	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	7.30	10.28	HGL ok
P-148	B3 West	MH-145	1.20	7.65	7.65	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	7.68	10.00	HGL ok
P-167	DI-167	DI-159	1.00	8.38	8.38	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.39	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	8.32	8.32	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	8.38	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	8.30	8.30	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	8.32	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.05	8.05	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	8.30	10.06	HGL ok
P-153	B1	MH-151	1.60	8.30	8.30	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	8.35	10.00	HGL ok
P-157	B3 North	MH-155	1.20	8.47	8.47	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.51	10.00	HGL ok
P-166	B2 North	MH-163	1.20	8.14	8.14	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	8.20	10.00	HGL ok
P-163	MH-163	MH-140	1.20	7.74	7.74	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	8.14	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)		

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	8.68	8.68	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.70	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	8.67	8.67	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.68	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	8.51	8.51	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	0.5	0.06	0.17	8.67	10.06	HGL ok
P-156	DI-156	DI-152	1.20	8.25	8.25	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	8.51	11.07	HGL ok
P-152	DI-152	MH-140	2.00	7.94	7.94	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	8.25	11.07	HGL ok
P-140	MH-140	DI-141	2.40	7.68	7.68	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	0.5	0.13	0.26	7.94	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.42	7.42	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	7.68	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.20	7.20	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	7.42	10.52	HGL ok
P-143	DI-143	MH-170	2.40	6.86	6.86	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	0.5	0.09	0.34	7.20	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.57	6.57	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	0.5	0.22	0.29	6.86	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.39	6.39	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	6.57	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.20	6.20	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	0.5	0.11	0.19	6.39	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	**0.5**	**0.13**	**0.26**	**6.20**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.57	6.57	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.57	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.57	6.57	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.57	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.39	6.39	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	6.46	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.39	6.39	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	6.46	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.58	6.58	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	7.23	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.20	6.20	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	1.3	1.0	0.33	0.38	6.58	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.30	6.78	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	6.90	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.20	6.20	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	1.3	1.0	0.08	0.10	6.30	9.25	HGL ok
P-115	B5 West	MH-116	1.20	9.54	9.54	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	9.60	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.29	9.29	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	0.5	0.10	0.24	9.54	11.99	HGL ok
P-117	DI-117	DI-118	1.20	8.98	8.98	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	9.29	11.71	HGL ok
P-118	DI-118	DI-113	1.20	8.65	8.65	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	8.98	11.30	HGL ok
P-113	DI-113	DI-114	1.20	7.89	7.89	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	8.65	11.30	HGL ok
P-114	DI-114	MH-170	1.20	6.86	6.86	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	7.89	10.75	HGL ok
P-110	B4 South	MH-111	1.20	8.93	8.93	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.96	10.00	HGL ok
P-111	MH-111	DI-112	1.20	8.82	8.82	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	0.5	0.05	0.11	8.93	11.99	HGL ok
P-112	DI-112	DI-113	1.20	8.65	8.65	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	1.3	1.0	0.07	0.17	8.82	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.50	7.50	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.50	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.45	7.45	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.05	7.50	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.34	7.34	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	7.45	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.22	7.22	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	0.5	0.09	0.13	7.34	8.91	HGL ok
P-124	DI-124	MH-135	1.60	7.05	7.05	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	7.22	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.22	7.22	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.22	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.34	7.34	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	7.40	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.38	7.38	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.38	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.33	7.33	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.05	7.38	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.23	7.23	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	1.3	1.0	0.03	0.10	7.33	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.16	7.16	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	0.5	0.05	0.07	7.23	8.91	HGL ok
P-134	DI-134	MH-135	1.60	7.05	7.05	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	7.16	9.44	HGL ok
P-135	MH-135	MH-170	2.00	6.86	6.86	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	0.5	0.08	0.19	7.05	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.23	7.23	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	7.27	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	7.85	7.85	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.85	11.02	HGL ok
P-145	MH-145	DI-146	1.20	7.73	7.73	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	7.85	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.50	7.50	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	7.73	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.20	7.20	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	7.50	10.28	HGL ok
P-148	B3 West	MH-145	1.20	7.85	7.85	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	7.88	10.00	HGL ok
P-167	DI-167	DI-159	1.00	8.58	8.58	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.59	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	8.52	8.52	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	8.58	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	8.50	8.50	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	8.52	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.25	8.25	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	8.50	10.06	HGL ok
P-153	B1	MH-151	1.60	8.50	8.50	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	8.55	10.00	HGL ok
P-157	B3 North	MH-155	1.20	8.67	8.67	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.71	10.00	HGL ok
P-166	B2 North	MH-163	1.20	8.34	8.34	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	8.40	10.00	HGL ok
P-163	MH-163	MH-140	1.20	7.94	7.94	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	8.34	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 50 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.18	12.18	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.20	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.17	12.17	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.18	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.01	12.01	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	*0.5*	0.06	0.17	12.17	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.75	11.75	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	12.01	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.44	11.44	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	11.75	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.18	11.18	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	*0.5*	0.13	0.26	11.44	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	10.92	10.92	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	11.18	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.70	10.70	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	10.92	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.36	10.36	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	*0.5*	0.09	0.34	10.70	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.07	10.07	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	*0.5*	0.22	0.29	10.36	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	9.89	9.89	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	*0.5*	0.10	0.17	10.07	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.70	9.70	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.19	9.89	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	***0.5***	**0.13**	**0.26**	**9.70**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.07	10.07	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.07	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.07	10.07	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.07	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.89	9.89	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	9.96	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.89	9.89	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.06	9.96	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.08	10.08	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	10.73	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.70	9.70	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	*1.3*	1.0	0.33	0.38	10.08	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.80	9.80	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	9.92	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.70	9.70	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	*1.3*	1.0	0.08	0.10	9.80	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.04	13.04	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.06	13.10	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.79	12.79	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	*0.5*	0.10	0.24	13.04	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.48	12.48	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	12.79	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.15	12.15	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	12.48	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.39	11.39	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	12.15	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.36	10.36	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	11.39	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.43	12.43	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	12.46	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.32	12.32	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	*0.5*	0.05	0.11	12.43	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.15	12.15	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	*1.3*	1.0	0.07	0.17	12.32	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.00	11.00	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.00	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.95	10.95	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.05	11.00	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.84	10.84	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.10	10.95	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.72	10.72	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	*0.5*	0.09	0.13	10.84	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.55	10.55	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	10.72	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.72	10.72	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.72	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.84	10.84	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.06	10.90	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.88	10.88	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.88	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.83	10.83	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.05	10.88	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.73	10.73	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	*1.3*	1.0	0.03	0.10	10.83	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.66	10.66	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	*0.5*	0.05	0.07	10.73	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.55	10.55	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	10.66	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.36	10.36	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	*0.5*	0.08	0.19	10.55	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.73	10.73	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	10.77	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.35	11.35	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.35	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.23	11.23	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	11.35	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.00	11.00	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	11.23	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.70	10.70	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	11.00	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.35	11.35	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.38	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.08	12.08	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.09	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.02	12.02	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.08	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.00	12.00	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.02	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.75	11.75	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	12.00	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.00	12.00	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	12.05	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.17	12.17	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.21	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.84	11.84	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	11.90	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.44	11.44	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	11.84	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 50 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add $Hc = 0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.68	12.68	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.70	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.67	12.67	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.68	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.51	12.51	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	*0.5*	0.06	0.17	12.67	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.25	12.25	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	12.51	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.94	11.94	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	12.25	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.68	11.68	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	*0.5*	0.13	0.26	11.94	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.42	11.42	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	11.68	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.20	11.20	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	11.42	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.86	10.86	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	*0.5*	0.09	0.34	11.20	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.57	10.57	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	*0.5*	0.22	0.29	10.86	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.39	10.39	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	*0.5*	0.10	0.17	10.57	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.20	10.20	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.19	10.39	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	***0.5***	**0.13**	**0.26**	**10.20**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.57	10.57	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.57	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.57	10.57	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.57	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.39	10.39	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	10.46	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.39	10.39	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.06	10.46	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.58	10.58	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	11.23	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.20	10.20	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	*1.3*	1.0	0.33	0.38	10.58	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.30	10.30	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	10.42	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.20	10.20	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	*1.3*	1.0	0.08	0.10	10.30	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.54	13.54	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.06	13.60	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.29	13.29	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	*0.5*	0.10	0.24	13.54	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.98	12.98	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	13.29	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.65	12.65	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	12.98	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.89	11.89	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	12.65	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.86	10.86	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	11.89	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.93	12.93	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	12.96	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.82	12.82	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	*0.5*	0.05	0.11	12.93	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.65	12.65	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	*1.3*	1.0	0.07	0.17	12.82	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.50	11.50	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.50	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.45	11.45	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.05	11.50	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.34	11.34	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.10	11.45	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.22	11.22	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	*0.5*	0.09	0.13	11.34	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.05	11.05	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	11.22	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.22	11.22	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.22	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.34	11.34	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.06	11.40	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.38	11.38	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.38	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.33	11.33	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.05	11.38	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.23	11.23	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	*1.3*	1.0	0.03	0.10	11.33	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.16	11.16	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	*0.5*	0.05	0.07	11.23	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.05	11.05	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	11.16	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.86	10.86	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	*0.5*	0.08	0.19	11.05	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.23	11.23	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	11.27	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.85	11.85	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.85	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.73	11.73	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	11.85	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.50	11.50	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	11.73	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.20	11.20	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	11.50	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.85	11.85	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.88	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.58	12.58	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.59	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.52	12.52	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.58	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.50	12.50	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.52	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.25	12.25	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	12.50	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.50	12.50	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	12.55	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.67	12.67	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.71	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.34	12.34	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	12.40	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.94	11.94	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	12.34	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle Δ_o	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Hi= H_Δ +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	13.08	13.08	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.10	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.07	13.07	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.08	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.91	12.91	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	0.5	0.06	0.17	13.07	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.65	12.65	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	12.91	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.34	12.34	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	12.65	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.08	12.08	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	0.5	0.13	0.26	12.34	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.82	11.82	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	12.08	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.60	11.60	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	11.82	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.26	11.26	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	0.5	0.09	0.34	11.60	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.97	10.97	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	0.5	0.22	0.29	11.26	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.79	10.79	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	10.97	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.60	10.60	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	0.5	0.11	0.19	10.79	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	**0.5**	**0.13**	**0.26**	**10.60**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.97	10.97	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.97	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.97	10.97	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.97	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.79	10.79	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	10.86	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.79	10.79	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	10.86	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.98	10.98	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	11.63	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.60	10.60	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	1.3	1.0	0.33	0.38	10.98	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.70	10.70	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	10.82	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.60	10.60	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	1.3	1.0	0.08	0.10	10.70	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.94	13.94	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	14.00	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.69	13.69	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	0.5	0.10	0.24	13.94	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.38	13.38	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	13.69	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.05	13.05	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	13.38	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.29	12.29	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	13.05	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.26	11.26	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	12.29	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.33	13.33	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.36	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.22	13.22	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	0.5	0.05	0.11	13.33	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.05	13.05	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	1.3	1.0	0.07	0.17	13.22	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.90	11.90	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.90	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.85	11.85	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.05	11.90	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.74	11.74	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	11.85	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.62	11.62	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	0.5	0.09	0.13	11.74	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.45	11.45	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	11.62	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.62	11.62	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.62	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.74	11.74	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	11.80	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.78	11.78	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.78	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.73	11.73	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.05	11.78	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.63	11.63	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	1.3	1.0	0.03	0.10	11.73	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.56	11.56	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	0.5	0.05	0.07	11.63	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.45	11.45	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	11.56	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.26	11.26	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	0.5	0.08	0.19	11.45	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.63	11.63	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.67	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.25	12.25	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.25	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.13	12.13	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	12.25	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.90	11.90	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	12.13	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.60	11.60	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	11.90	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.25	12.25	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.28	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.98	12.98	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.99	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.92	12.92	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.98	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.90	12.90	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.92	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.65	12.65	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	12.90	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.90	12.90	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	12.95	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.07	13.07	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.11	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.74	12.74	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	12.80	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.34	12.34	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	12.74	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 50 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	**HGL Check**
P-158	DI-158	DI-154	1.00	13.58	13.58	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.60	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.57	13.57	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.58	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.41	13.41	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	0.5	0.06	0.17	13.57	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.15	13.15	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	13.41	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.84	12.84	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	13.15	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.58	12.58	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	0.5	0.13	0.26	12.84	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.32	12.32	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	12.58	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.10	12.10	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	12.32	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.76	11.76	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	0.5	0.09	0.34	12.10	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.47	11.47	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	0.5	0.22	0.29	11.76	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.29	11.29	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	11.47	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.10	11.10	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	0.5	0.11	0.19	11.29	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	**0.5**	**0.13**	**0.26**	**11.10**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.47	11.47	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.47	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.47	11.47	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.47	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.29	11.29	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	11.36	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.29	11.29	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	11.36	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.48	11.48	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	12.13	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.10	11.10	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	1.3	1.0	0.33	0.38	11.48	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.20	11.20	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	11.32	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.10	11.10	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	1.3	1.0	0.08	0.10	11.20	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.44	14.44	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	14.50	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.19	14.19	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	0.5	0.10	0.24	14.44	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.88	13.88	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	14.19	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.55	13.55	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	13.88	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.79	12.79	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	13.55	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.76	11.76	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	12.79	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.83	13.83	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.86	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.72	13.72	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	0.5	0.05	0.11	13.83	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.55	13.55	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	1.3	1.0	0.07	0.17	13.72	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.40	12.40	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.40	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.35	12.35	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.05	12.40	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.24	12.24	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	12.35	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.12	12.12	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	0.5	0.09	0.13	12.24	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.95	11.95	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	12.12	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.12	12.12	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.12	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.24	12.24	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	12.30	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.28	12.28	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.28	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.23	12.23	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.05	12.28	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.13	12.13	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	1.3	1.0	0.03	0.10	12.23	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.06	12.06	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	0.5	0.05	0.07	12.13	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.95	11.95	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	12.06	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.76	11.76	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	0.5	0.08	0.19	11.95	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.13	12.13	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.17	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.75	12.75	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.75	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.63	12.63	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	12.75	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.40	12.40	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	12.63	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.10	12.10	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	12.40	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.75	12.75	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.78	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.48	13.48	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.49	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.42	13.42	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.48	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.40	13.40	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.42	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.15	13.15	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	13.40	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.40	13.40	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	13.45	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.57	13.57	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.61	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.24	13.24	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	13.30	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.84	12.84	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	13.24	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 50 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
			0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	14.28	14.28	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.30	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	14.27	14.27	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.28	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	14.11	14.11	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	0.5	0.06	0.17	14.27	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.85	13.85	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	14.11	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	13.54	13.54	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	13.85	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	13.28	13.28	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	0.5	0.13	0.26	13.54	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	13.02	13.02	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	13.28	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.80	12.80	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	13.02	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.46	12.46	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	0.5	0.09	0.34	12.80	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.17	12.17	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	0.5	0.22	0.29	12.46	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.99	11.99	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	12.17	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.80	11.80	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	0.5	0.11	0.19	11.99	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	**0.5**	**0.13**	**0.26**	**11.80**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.17	12.17	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.17	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.17	12.17	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.17	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.99	11.99	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	12.06	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.99	11.99	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	12.06	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.18	12.18	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	12.83	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.80	11.80	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	1.3	1.0	0.33	0.38	12.18	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.90	11.90	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	12.02	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.80	11.80	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	1.3	1.0	0.08	0.10	11.90	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	15.14	15.14	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	15.20	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.89	14.89	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	0.5	0.10	0.24	15.14	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.58	14.58	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	14.89	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	14.25	14.25	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	14.58	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.49	13.49	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	14.25	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.46	12.46	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	13.49	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.53	14.53	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.56	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.42	14.42	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	0.5	0.05	0.11	14.53	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	14.25	14.25	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	1.3	1.0	0.07	0.17	14.42	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	13.10	13.10	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.10	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	13.05	13.05	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.05	13.10	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.94	12.94	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	13.05	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.82	12.82	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	0.5	0.09	0.13	12.94	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.65	12.65	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	12.82	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.82	12.82	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.82	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.94	12.94	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	13.00	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.98	12.98	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.98	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.93	12.93	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.05	12.98	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.83	12.83	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	1.3	1.0	0.03	0.10	12.93	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.76	12.76	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	0.5	0.05	0.07	12.83	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.65	12.65	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	12.76	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.46	12.46	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	0.5	0.08	0.19	12.65	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.83	12.83	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.87	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	13.45	13.45	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.45	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.33	13.33	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	13.45	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	13.10	13.10	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	13.33	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.80	12.80	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	13.10	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	13.45	13.45	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.48	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	14.18	14.18	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.19	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	14.12	14.12	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	14.18	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	14.10	14.10	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.12	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.85	13.85	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	14.10	10.06	HGL Too High!
P-153	B1	MH-151	1.60	14.10	14.10	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	14.15	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	14.27	14.27	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.31	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.94	13.94	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	14.00	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.54	13.54	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	13.94	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	14.78	14.78	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.80	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	14.77	14.77	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.78	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	14.61	14.61	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	0.5	0.06	0.17	14.77	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	14.35	14.35	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	14.61	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	14.04	14.04	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	14.35	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	13.78	13.78	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	0.5	0.13	0.26	14.04	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	13.52	13.52	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	13.78	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	13.30	13.30	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	13.52	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.96	12.96	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	0.5	0.09	0.34	13.30	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.67	12.67	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	0.5	0.22	0.29	12.96	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	12.49	12.49	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	0.5	0.10	0.17	12.67	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	12.30	12.30	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	0.5	0.11	0.19	12.49	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	**0.5**	**0.13**	**0.26**	**12.30**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.67	12.67	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.67	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.67	12.67	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.67	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	12.49	12.49	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	12.56	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	12.49	12.49	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	12.56	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.68	12.68	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	13.33	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	12.30	12.30	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	1.3	1.0	0.33	0.38	12.68	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	12.40	12.40	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	12.52	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	12.30	12.30	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	1.3	1.0	0.08	0.10	12.40	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	15.64	15.64	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	15.70	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	15.39	15.39	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	0.5	0.10	0.24	15.64	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	15.08	15.08	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	15.39	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	14.75	14.75	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	15.08	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.99	13.99	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	14.75	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.96	12.96	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	13.99	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	15.03	15.03	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	15.06	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.92	14.92	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	0.5	0.05	0.11	15.03	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	14.75	14.75	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	1.3	1.0	0.07	0.17	14.92	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	13.60	13.60	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.60	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	13.55	13.55	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	1.3	1.0	0.01	0.05	13.60	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	13.44	13.44	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	1.3	1.0	0.04	0.10	13.55	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	13.32	13.32	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	0.5	0.09	0.13	13.44	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	13.15	13.15	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	13.32	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	13.32	13.32	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.32	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	13.44	13.44	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	13.50	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	13.48	13.48	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.48	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	13.43	13.43	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.05	13.48	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	13.33	13.33	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	1.3	1.0	0.03	0.10	13.43	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	13.26	13.26	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	0.5	0.05	0.07	13.33	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	13.15	13.15	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	13.26	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.96	12.96	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	0.5	0.08	0.19	13.15	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	13.33	13.33	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.37	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	13.95	13.95	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.95	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.83	13.83	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	13.95	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	13.60	13.60	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	13.83	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	13.30	13.30	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	13.60	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	13.95	13.95	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.98	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	14.68	14.68	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.69	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	14.62	14.62	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	14.68	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	14.60	14.60	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.62	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	14.35	14.35	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	14.60	10.06	HGL Too High!
P-153	B1	MH-151	1.60	14.60	14.60	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	14.65	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	14.77	14.77	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.81	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	14.44	14.44	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	14.50	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	14.04	14.04	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	14.44	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 50 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	16.08	16.08	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.10	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	16.07	16.07	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.08	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	15.91	15.91	18	5.2	2.9	89	51	0.0021	0.10	0	0.00	0.03	1.1	9.6	0.0	2.3	0.0	89	0.06	0.12	1.0	*0.5*	0.06	0.17	16.07	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	15.65	15.65	18	5.5	3.1	94	33	0.0024	0.08	0	0.00	0.04	15.0	0.0	0.0	2.9	0.0	89	0.09	0.18	1.0	1.0	0.18	0.26	15.91	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	15.34	15.34	30	17.8	3.6	85	97	0.0016	0.16	0	0.00	0.05	17.4	47.1	0.0	3.9	0.1	3	0.02	0.16	1.0	1.0	0.16	0.31	15.65	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	15.08	15.08	36	26.3	3.7	2	97	0.0013	0.13	0	0.00	0.05	64.4	47.6	0.0	3.6	0.1	85	0.14	0.26	1.0	*0.5*	0.13	0.26	15.34	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	14.82	14.82	36	26.6	3.8	1	96	0.0014	0.13	0	0.00	0.05	97.7	0.0	0.0	3.7	0.1	2	0.00	0.13	1.0	1.0	0.13	0.26	15.08	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	14.60	14.60	36	26.8	3.8	5	68	0.0014	0.09	0	0.00	0.06	99.9	0.0	0.0	3.8	0.1	1	0.00	0.13	1.0	1.0	0.13	0.23	14.82	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	14.26	14.26	36	33.2	4.7	86	115	0.0021	0.24	0	0.00	0.09	101.7	20.0	0.0	3.8	0.1	5	0.02	0.19	1.0	*0.5*	0.09	0.34	14.60	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	13.97	13.97	48	58.1	4.6	0	55	0.0014	0.08	0	0.00	0.08	155.8	73.3	48.6	4.7	0.1	86	0.23	0.44	1.0	*0.5*	0.22	0.29	14.26	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	13.79	13.79	48	59.2	4.7	0	50	0.0014	0.07	0	0.00	0.09	268.8	0.3	0.3	4.6	0.1	0	0.00	0.20	1.0	*0.5*	0.10	0.17	13.97	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	13.60	13.60	48	65.6	5.2	0	44	0.0018	0.08	0	0.00	0.11	278.6	8.2	7.5	4.7	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.19	13.79	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**69.5**	**5.5**	**0**	**64**	**0.0020**	**0.13**	**0**	**0.00**	**0.12**	**342.3**	**6.2**	**3.2**	**5.2**	**0.1**	**0**	**0.00**	**0.27**	**1.0**	***0.5***	**0.13**	**0.26**	**13.60**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	13.97	13.97	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.97	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	13.97	13.97	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.97	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	13.79	13.79	18	3.8	2.2	90	55	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	13.86	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	13.79	13.79	18	3.6	2.1	90	55	0.0010	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.06	13.86	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	13.98	13.98	8	1.5	4.2	56	56	0.0104	0.58	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.65	14.63	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	13.60	13.60	15	2.8	2.2	90	30	0.0016	0.05	0	0.00	0.02	6.1	0.0	0.0	4.2	0.1	56	0.14	0.26	*1.3*	1.0	0.33	0.38	13.98	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	13.70	13.70	8	0.7	2.0	45	45	0.0023	0.10	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.12	13.82	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	13.60	13.60	15	2.0	1.6	90	30	0.0008	0.02	0	0.00	0.01	1.3	0.0	0.0	2.0	0.0	45	0.03	0.06	*1.3*	1.0	0.08	0.10	13.70	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	16.94	16.94	18	5.6	3.2	86	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.06	17.00	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	16.69	16.69	18	5.6	3.2	4	60	0.0024	0.14	0	0.00	0.04	17.8	0.0	0.0	3.2	0.1	86	0.11	0.20	1.0	*0.5*	0.10	0.24	16.94	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	16.38	16.38	18	6.0	3.4	89	71	0.0028	0.20	0	0.00	0.05	17.6	0.0	0.0	3.2	0.1	4	0.02	0.11	1.0	1.0	0.11	0.31	16.69	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	16.05	16.05	18	6.5	3.7	72	27	0.0033	0.09	0	0.00	0.05	20.6	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.33	16.38	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	15.29	15.29	18	11.2	6.3	25	41	0.0096	0.39	0	0.00	0.16	23.8	10.3	0.0	3.7	0.1	72	0.13	0.36	1.0	1.0	0.36	0.75	16.05	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	14.26	14.26	18	11.4	6.4	97	47	0.0100	0.47	0	0.00	0.16	70.6	0.0	0.0	6.3	0.2	25	0.19	0.56	1.0	1.0	0.56	1.03	15.29	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	16.33	16.33	18	3.8	2.2	86	17	0.0011	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	16.36	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	16.22	16.22	18	3.8	2.1	4	60	0.0011	0.07	0	0.00	0.02	8.2	0.0	0.0	2.2	0.0	86	0.05	0.09	1.0	*0.5*	0.05	0.11	16.33	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	16.05	16.05	18	4.3	2.4	19	71	0.0014	0.10	0	0.00	0.02	8.1	0.0	0.0	2.1	0.0	4	0.01	0.05	*1.3*	1.0	0.07	0.17	16.22	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	14.90	14.90	15	0.5	0.4	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.90	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	14.85	14.85	15	1.6	1.3	7	84	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.05	14.90	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	14.74	14.74	15	2.4	2.0	14	56	0.0012	0.07	0	0.00	0.02	2.1	0.0	0.0	1.3	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.10	14.85	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	14.62	14.62	24	7.8	2.5	81	36	0.0010	0.04	0	0.00	0.02	4.8	17.5	0.0	3.2	0.1	81	0.10	0.18	1.0	*0.5*	0.09	0.13	14.74	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	14.45	14.45	24	8.6	2.7	90	31	0.0012	0.04	0	0.00	0.03	19.2	0.1	0.0	2.5	0.0	81	0.06	0.12	1.0	1.0	0.12	0.16	14.62	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	14.62	14.62	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.62	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	14.74	14.74	18	5.6	3.2	81	17	0.0024	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.06	14.80	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	14.78	14.78	15	0.5	0.4	6	22	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.78	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	14.73	14.73	15	1.5	1.2	5	83	0.0005	0.04	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.05	14.78	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	14.63	14.63	15	2.4	1.9	14	56	0.0012	0.06	0	0.00	0.01	1.9	0.0	0.0	1.2	0.0	5	0.00	0.03	*1.3*	1.0	0.03	0.10	14.73	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	14.56	14.56	24	6.3	2.0	81	36	0.0007	0.02	0	0.00	0.02	4.6	9.6	0.0	2.3	0.0	81	0.06	0.10	1.0	*0.5*	0.05	0.07	14.63	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	14.45	14.45	24	7.0	2.2	90	31	0.0008	0.03	0	0.00	0.02	12.6	0.0	0.0	2.0	0.0	81	0.04	0.08	1.0	1.0	0.08	0.11	14.56	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	14.26	14.26	30	15.4	3.1	0	94	0.0012	0.11	0	0.00	0.04	15.5	23.5	0.0	2.7	0.0	90	0.08	0.16	1.0	*0.5*	0.08	0.19	14.45	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	14.63	14.63	18	4.1	2.3	81	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	14.67	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	15.25	15.25	15	0.4	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.25	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	15.13	15.13	18	4.5	2.5	7	39	0.0016	0.06	0	0.00	0.02	0.2	9.6	0.0	2.3	0.0	83	0.06	0.11	1.0	0.5	0.06	0.12	15.25	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	14.90	14.90	18	5.1	2.9	89	68	0.0020	0.14	0	0.00	0.03	11.4	0.0	0.0	2.5	0.0	7	0.01	0.08	1.3	1.0	0.10	0.24	15.13	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	14.60	14.60	18	5.9	3.4	86	25	0.0027	0.07	0	0.00	0.04	14.7	0.0	0.0	2.9	0.0	89	0.09	0.18	1.3	1.0	0.23	0.30	14.90	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	15.25	15.25	18	4.1	2.3	83	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	15.28	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	15.98	15.98	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.99	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	15.92	15.92	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	15.98	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	15.90	15.90	15	1.9	1.5	10	24	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	15.92	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	15.65	15.65	24	12.2	3.9	3	51	0.0025	0.13	0	0.00	0.06	2.9	33.9	0.0	3.3	0.1	89	0.12	0.23	1.0	0.5	0.12	0.24	15.90	10.06	HGL Too High!
P-153	B1	MH-151	1.60	15.90	15.90	24	10.3	3.3	89	17	0.0018	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	15.95	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	16.07	16.07	18	4.1	2.3	89	18	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	16.11	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	15.74	15.74	18	3.6	2.1	90	50	0.0010	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.06	15.80	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	15.34	15.34	18	9.2	5.2	92	44	0.0065	0.29	0	0.00	0.10	7.4	0.0	7.4	2.1	0.0	90	0.05	0.17	1.3	0.5	0.11	0.40	15.74	10.50	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 100	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-158	DI-158	DI-154	3887	225	4112	0.09	0.91	0.09	0.09	6.0	0.00	4.01	**0.34**	15	100	0.012	0.000024	0.0053	4.2	**5.1**	2.0	0.82	6.82	**4.36**	3.83	Q ok
P-154	DI-154	MH-155	3023	31	3054	0.07	1.00	0.07	0.16	6.0	6.82	7.46	**1.16**	15	24	0.012	0.000276	0.0042	3.7	**4.5**	3.0	0.13	6.95	**3.73**	3.63	Q ok
P-155	MH-155	DI-156	1	0	1	0.00	1.00	0.00	0.72	6.0	6.95	7.40	**5.32**	18	51	0.012	0.002189	0.0039	4.0	**7.1**	4.5	0.19	7.14	3.53	3.33	Q ok
P-156	DI-156	DI-152	2725	0	2725	0.06	1.00	0.06	0.78	6.0	7.14	7.36	**5.76**	18	33	0.012	0.002563	0.0039	4.0	**7.1**	4.5	0.12	7.26	3.23	3.10	Q ok
P-152	DI-152	MH-140	3517	0	3517	0.08	1.00	0.08	2.52	6.0	7.26	7.30	**18.39**	**30**	97	0.012	0.001714	0.0040	5.7	**28.2**	6.1	0.26	7.53	3.00	2.61	Q ok
P-140	MH-140	DI-141	1	0	1	0.00	1.00	0.00	3.79	6.0	7.53	7.23	**27.40**	36	97	0.012	0.001438	0.0040	6.5	**45.8**	6.8	0.24	7.76	2.51	2.12	Q ok
P-141	DI-141	DI-142	3263	65	3328	0.08	1.00	0.08	3.87	6.0	7.76	7.13	**27.57**	36	96	0.012	0.001456	0.0040	6.4	**45.5**	6.8	0.24	8.00	2.02	1.64	Q ok
P-142	DI-142	DI-143	3699	195	3894	0.09	1.00	0.09	3.96	6.0	8.00	7.06	**27.94**	36	68	0.012	0.001496	0.0040	6.4	**45.5**	6.8	0.17	8.17	1.54	1.27	Q ok
P-143	DI-143	MH-170	5428	266	5694	0.13	1.00	0.13	4.93	6.0	8.17	7.00	**34.47**	36	115	0.012	0.002276	0.0040	6.5	**45.7**	7.2	0.27	8.44	1.17	0.71	Q ok
P-170	MH-170	MH-171	1	0	1	0.00	1.00	0.00	8.79	6.0	8.44	6.93	**60.93**	48	55	0.012	0.001533	0.0040	7.8	**98.4**	8.2	0.11	8.55	0.61	0.39	Q ok
P-171	MH-171	MH-172	1	0	1	0.00	1.00	0.00	8.99	6.0	8.55	6.90	**62.03**	48	50	0.012	0.001589	0.0040	7.8	**98.4**	8.4	0.10	8.65	0.29	0.09	Q ok
P-172	MH-172	MH-173	1	0	1	0.00	1.00	0.00	10.02	6.0	8.65	6.86	**68.76**	48	44	0.012	0.001952	0.0041	7.9	**99.5**	8.6	0.08	8.73	-0.01	-0.19	Q ok
P-173	MH-173	OUTFALL	1	0	1	0.00	1.00	0.00	10.68	6.0	8.73	6.83	**72.97**	**48**	64	0.012	0.002199	0.0041	7.9	**99.2**	8.8	0.12	8.85	-0.29	**-0.55**	Q ok
P-174	DI-174	MH-171	3578	530	4108	0.09	1.00	0.09	0.09	6.0	0.00	7.73	**0.73**	18	33	0.012	0.000041	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-175	DI-175	MH-171	4118	530	4648	0.11	1.00	0.11	0.11	6.0	0.00	7.73	**0.82**	18	33	0.012	0.000053	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-176	B4 North	MH-172	22780	0	22780	0.52	1.00	0.52	0.52	6.0	0.00	7.73	**4.04**	18	55	0.012	0.001261	0.0049	4.5	**8.0**	4.5	0.21	6.21	1.26	0.99	Q ok
P-177	B2 South	MH-172	21809	0	21809	0.50	1.00	0.50	0.50	6.0	0.00	7.73	**3.87**	18	55	0.012	0.001156	0.0049	4.5	**8.0**	4.5	0.21	6.21	1.26	0.99	Q ok
P-178	TD-03	DI-179	8687	0	8687	0.20	1.00	0.20	0.20	6.0	0.00	7.73	**1.54**	8	56	0.011	0.011646	0.0509	9.2	**3.2**	9.1	0.10	6.10	8.55	5.70	Q ok
P-179	DI-179	MH-173	6306	3055	9361	0.21	0.87	0.19	0.39	6.0	6.10	7.69	**2.98**	15	30	0.012	0.001812	0.0500	12.8	**15.6**	9.6	0.05	6.15	3.21	1.71	Q ok
P-180	TD-02	DI-181	4084	0	4084	0.09	1.00	0.09	0.09	6.0	0.00	7.73	**0.72**	8	45	0.011	0.002574	0.0500	9.1	**3.2**	7.5	0.10	6.10	8.50	6.25	Q ok
P-181	DI-181	MH-173	6222	2906	9128	0.21	0.88	0.18	0.28	6.0	6.10	7.69	**2.14**	15	30	0.012	0.000937	0.0500	12.8	**15.6**	8.9	0.06	6.16	3.21	1.71	Q ok
P-115	B5 West	MH-116	33468	0	33468	0.77	1.00	0.77	0.77	6.0	0.00	7.73	**5.94**	18	17	0.012	0.002722	0.0047	4.4	**7.8**	4.9	0.06	6.06	3.84	3.76	Q ok
P-116	MH-116	DI-117	1	0	1	0.00	1.00	0.00	0.77	6.0	6.06	7.69	**5.91**	18	60	0.012	0.002699	0.0050	4.6	**8.0**	5.1	0.20	6.26	3.66	3.36	Q ok
P-117	DI-117	DI-118	2919	167	3086	0.07	1.00	0.07	0.84	6.0	6.26	7.63	**6.40**	18	71	0.012	0.003165	0.0051	4.6	**8.1**	5.1	0.23	6.49	3.26	2.90	Q ok
P-118	DI-118	DI-113	2866	196	3062	0.07	1.00	0.07	0.91	6.0	6.49	7.56	**6.88**	18	27	0.012	0.003653	0.0048	4.5	**7.9**	5.0	0.09	6.58	2.80	2.67	Q ok
P-113	DI-113	DI-114	2882	195	3077	0.07	1.00	0.07	1.57	6.0	6.58	7.53	**11.84**	18	41	0.012	0.010820	0.0200	9.1	**16.1**	10.1	0.07	6.64	2.57	1.75	Q ok
P-114	DI-114	MH-170	1592	20	1612	0.04	1.00	0.04	1.61	6.0	6.64	7.53	**12.12**	18	47	0.012	0.011335	0.0200	9.1	**16.1**	10.1	0.08	6.72	1.65	0.71	Q ok
P-110	B4 South	MH-111	22751	0	22751	0.52	1.00	0.52	0.52	6.0	0.00	7.73	**4.04**	18	17	0.012	0.001258	0.0053	4.7	**8.3**	4.6	0.06	6.06	3.61	3.52	Q ok
P-111	MH-111	DI-112	1	0	1	0.00	1.00	0.00	0.52	6.0	6.06	7.69	**4.02**	18	60	0.012	0.001247	0.0050	4.6	**8.0**	4.5	0.22	6.28	3.42	3.12	Q ok
P-112	DI-112	DI-113	2877	164	3041	0.07	1.00	0.07	0.59	6.0	6.28	7.63	**4.52**	18	71	0.012	0.001576	0.0049	4.5	**8.0**	4.6	0.26	6.54	3.02	2.67	Q ok
P-120	DI-120	DI-121	2879	334	3213	0.07	1.00	0.07	0.07	6.0	0.00	7.73	**0.57**	15	22	0.012	0.000066	0.0032	3.2	**3.9**	2.3	0.16	6.16	**3.96**	3.89	Q ok
P-121	DI-121	DI-122	5403	1316	6719	0.15	1.00	0.15	0.23	6.0	6.16	7.66	**1.75**	15	84	0.012	0.000622	0.0031	3.2	**3.9**	3.1	0.45	6.62	3.79	3.53	Q ok
P-122	DI-122	MH-123	4404	1304	5708	0.13	0.97	0.13	0.35	6.0	6.62	7.53	**2.67**	15	56	0.012	0.001456	0.0030	3.1	**3.9**	3.4	0.27	6.89	3.43	3.26	Q ok
P-123	MH-123	DI-124	1	0	1	0.00	1.00	0.00	1.12	6.0	6.89	7.43	**8.31**	**24**	36	0.012	0.001150	0.0036	4.7	**14.7**	4.8	0.13	7.02	3.16	3.03	Q ok
P-124	DI-124	MH-135	3437	323	3760	0.09	1.00	0.09	1.24	6.0	7.02	7.40	**9.18**	**24**	31	0.012	0.001404	0.0048	5.4	**17.0**	5.5	0.09	7.11	2.93	2.78	Q ok
P-125	DI-125	DI-124	1587	15	1602	0.04	1.00	0.04	0.04	6.0	0.00	7.73	**0.28**	15	45	0.012	0.000016	0.0040	3.6	**4.4**	1.8	0.42	6.42	3.21	3.03	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 100	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-126	B5 North	MH-123	33276	0	33276	0.76	1.00	0.76	0.76	6.0	0.00	7.73	**5.90**	18	17	0.012	0.002691	0.0053	4.7	**8.3**	5.1	0.06	6.06	3.36	3.27	Q ok
P-130	DI-130	DI-131	2606	339	2945	0.07	1.00	0.07	0.07	6.0	0.00	7.73	**0.52**	15	22	0.012	0.000056	0.0032	3.2	**3.9**	2.3	0.16	6.16	**3.96**	3.89	Q ok
P-131	DI-131	DI-132	5203	1533	6736	0.15	0.97	0.15	0.22	6.0	6.16	7.66	**1.67**	15	83	0.012	0.000566	0.0030	3.1	**3.8**	3.0	0.46	6.62	3.79	3.54	Q ok
P-132	DI-132	MH-133	4517	1246	5763	0.13	0.98	0.13	0.35	6.0	6.62	7.53	**2.61**	15	56	0.012	0.001393	0.0030	3.1	**3.9**	3.4	0.27	6.89	3.44	3.27	Q ok
P-133	MH-133	DI-134	1	0	1	0.00	1.00	0.00	0.91	6.0	6.89	7.43	**6.77**	24	36	0.012	0.000763	0.0031	4.3	**13.5**	4.3	0.14	7.03	3.17	3.06	Q ok
P-134	DI-134	MH-135	4193	284	4477	0.10	1.00	0.10	1.01	6.0	7.03	7.40	**7.50**	**24**	31	0.012	0.000936	0.0035	4.6	**14.6**	4.6	0.11	7.14	2.96	2.85	Q ok
P-135	MH-135	MH-170	1	0	1	0.00	1.00	0.00	2.26	6.0	7.14	7.36	**16.61**	**30**	94	0.012	0.001397	0.0039	5.7	**27.9**	6.0	0.26	7.41	2.67	2.30	Q ok
P-136	B3 South	MH-133	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	7.73	**4.36**	18	17	0.012	0.001467	0.0047	4.4	**7.8**	4.5	0.06	6.06	3.36	3.28	Q ok
P-144	DI-144	MH-145	2618	65	2683	0.06	1.00	0.06	0.06	6.0	0.00	7.73	**0.48**	15	55	0.012	0.000046	0.0051	4.1	**5.0**	2.4	0.38	6.38	3.79	3.51	Q ok
P-145	MH-145	DI-146	1	0	1	0.00	1.00	0.00	0.63	6.0	6.38	7.60	**4.75**	18	39	0.012	0.001744	0.0049	4.5	**7.9**	4.7	0.14	6.51	3.41	3.22	Q ok
P-146	DI-146	DI-147	3675	195	3870	0.09	1.00	0.09	0.71	6.0	6.51	7.56	**5.40**	18	68	0.012	0.002254	0.0050	4.6	**8.0**	4.9	0.23	6.75	3.12	2.78	Q ok
P-147	DI-147	DI-143	5191	266	5457	0.13	1.00	0.13	0.84	6.0	6.75	7.50	**6.29**	18	25	0.012	0.003060	0.0052	4.6	**8.2**	5.2	0.08	6.83	2.68	2.55	Q ok
P-148	B3 West	MH-145	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	7.73	**4.36**	18	17	0.012	0.001467	0.0053	4.7	**8.3**	4.8	0.06	6.06	3.60	3.51	Q ok
P-167	DI-167	DI-159	3909	227	4136	0.09	0.91	0.09	0.09	6.0	6.00	4.01	**0.35**	15	18	0.012	0.000024	0.0033	3.3	**4.0**	2.0	0.15	6.15	4.29	4.23	Q ok
P-159	DI-159	DI-150	3909	227	4136	0.09	0.91	0.09	0.17	6.0	6.15	3.98	**0.69**	15	100	0.012	0.000096	0.0053	4.2	**5.1**	2.9	0.57	6.73	4.13	3.60	Q ok
P-150	DI-150	MH-151	3037	0	3037	0.07	1.00	0.07	0.24	6.0	0.00	7.73	**1.87**	15	24	0.012	0.000715	0.0042	3.7	**4.5**	3.4	0.12	6.12	3.50	3.40	Q ok
P-151	MH-151	DI-152	1	0	1	0.00	1.00	0.00	1.66	6.0	6.12	7.69	**12.76**	24	51	0.012	0.002709	0.0039	4.9	**15.3**	5.5	0.15	6.27	3.30	3.10	Q ok
P-153	B1	MH-151	61668	0	61668	1.42	1.00	1.42	1.42	6.0	0.00	7.73	**10.94**	24	17	0.012	0.001993	0.0100	7.8	**24.5**	7.6	0.04	6.04	3.57	3.40	Q ok
P-157	B3 North	MH-155	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	7.73	**4.36**	18	18	0.012	0.001467	0.0050	4.6	**8.0**	4.6	0.06	6.06	3.72	3.63	Q ok
P-166	B2 North	MH-163	21657	0	21657	0.50	1.00	0.50	0.50	6.0	0.00	7.73	**3.84**	18	50	0.012	0.001140	0.0050	4.6	**8.0**	4.5	0.18	6.18	3.62	3.37	Q ok
P-163	MH-163	MH-140	1	0	1	0.00	1.00	0.00	1.27	6.0	6.18	7.66	**9.72**	18	44	0.012	0.007299	0.0150	7.9	**13.9**	8.6	0.09	6.27	3.27	2.61	Q ok

KEY	
	Upsized from Semi-Final Design to have capacity for 50-yr design storm
	Optional Upsize-50-yr design storm results in >85% Full
	No Change from Semi-Final Design

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 100 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	6.28	6.28	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.30	7.70	HGL ok
P-154	DI-154	MH-155	1.00	6.27	6.27	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.28	9.06	HGL ok
P-155	MH-155	DI-156	1.20	6.09	6.09	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	0.5	0.07	0.19	6.27	10.06	HGL ok
P-156	DI-156	DI-152	1.20	5.80	5.80	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	6.09	11.07	HGL ok
P-152	DI-152	MH-140	2.00	5.45	5.45	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	5.80	11.07	HGL ok
P-140	MH-140	DI-141	2.40	5.16	5.16	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	0.5	0.15	0.29	5.45	12.04	HGL ok
P-141	DI-141	DI-142	2.40	4.87	4.87	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	5.16	11.02	HGL ok
P-142	DI-142	DI-143	2.40	4.61	4.61	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	4.87	10.52	HGL ok
P-143	DI-143	MH-170	2.40	4.24	4.24	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	0.5	0.10	0.38	4.61	10.28	HGL ok
P-170	MH-170	MH-171	3.20	3.91	3.91	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	0.5	0.24	0.33	4.24	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.71	3.71	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	0.5	0.11	0.20	3.91	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.49	3.49	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	0.5	0.13	0.22	3.71	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.20**	**3.20**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	**0.5**	**0.15**	**0.29**	**3.49**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	3.91	3.91	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.91	10.61	HGL ok
P-175	DI-175	MH-171	1.20	3.91	3.91	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.91	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.71	3.71	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	3.79	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.71	3.71	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	3.78	10.00	HGL ok
P-178	TD-03	DI-179	0.53	3.92	6.23	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	6.96	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.49	3.49	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	1.3	1.0	0.38	0.43	3.92	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.61	6.78	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	6.92	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.49	3.49	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	1.3	1.0	0.09	0.11	3.61	9.25	HGL ok
P-115	B5 West	MH-116	1.20	7.25	7.25	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	7.32	10.00	HGL ok
P-116	MH-116	DI-117	1.20	6.97	6.97	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	0.5	0.11	0.27	7.25	11.99	HGL ok
P-117	DI-117	DI-118	1.20	6.62	6.62	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	6.97	11.71	HGL ok
P-118	DI-118	DI-113	1.20	6.25	6.25	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	6.62	11.30	HGL ok
P-113	DI-113	DI-114	1.20	5.40	5.40	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	6.25	11.30	HGL ok
P-114	DI-114	MH-170	1.20	4.24	4.24	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	5.40	10.75	HGL ok
P-110	B4 South	MH-111	1.20	6.57	6.57	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	6.60	10.00	HGL ok
P-111	MH-111	DI-112	1.20	6.44	6.44	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	0.5	0.05	0.13	6.57	11.99	HGL ok
P-112	DI-112	DI-113	1.20	6.25	6.25	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	1.3	1.0	0.08	0.19	6.44	11.71	HGL ok
P-120	DI-120	DI-121	1.00	5.04	5.04	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.04	7.10	HGL ok
P-121	DI-121	DI-122	1.00	4.98	4.98	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.06	5.04	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.85	4.85	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	1.3	1.0	0.04	0.12	4.98	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.71	4.71	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	0.5	0.10	0.14	4.85	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.52	4.52	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	4.71	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.71	4.71	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.71	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.85	4.85	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	4.92	10.00	HGL ok
P-130	DI-130	DI-131	1.00	4.92	4.92	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.92	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.86	4.86	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	4.92	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.74	4.74	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.12	4.86	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.65	4.66	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	0.5	0.06	0.08	4.74	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.52	4.52	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	4.65	9.44	HGL ok
P-135	MH-135	MH-170	2.00	4.24	4.30	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	0.5	0.09	0.22	4.52	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.74	4.74	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	4.78	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	5.35	5.35	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.35	11.02	HGL ok
P-145	MH-145	DI-146	1.20	5.22	5.22	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	5.35	10.87	HGL ok
P-146	DI-146	DI-147	1.20	4.95	4.95	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	5.22	10.52	HGL ok
P-147	DI-147	DI-143	1.20	4.61	4.61	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	4.95	10.28	HGL ok
P-148	B3 West	MH-145	1.20	5.35	5.35	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	5.39	10.00	HGL ok
P-167	DI-167	DI-159	1.00	6.16	6.16	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.17	7.48	HGL ok
P-159	DI-159	DI-150	1.00	6.10	6.10	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	6.16	7.70	HGL ok
P-150	DI-150	MH-151	1.00	6.07	6.07	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	6.10	9.06	HGL ok
P-151	MH-151	DI-152	1.60	5.80	5.80	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	6.07	10.06	HGL ok
P-153	B1	MH-151	1.60	6.07	6.07	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	6.13	10.00	HGL ok
P-157	B3 North	MH-155	1.20	6.27	6.27	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	6.31	10.00	HGL ok
P-166	B2 North	MH-163	1.20	5.90	5.90	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	5.96	10.00	HGL ok
P-163	MH-163	MH-140	1.20	5.45	5.45	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	5.90	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle Δ_o	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	6.48	6.48	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.50	7.70	HGL ok
P-154	DI-154	MH-155	1.00	6.47	6.47	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.48	9.06	HGL ok
P-155	MH-155	DI-156	1.20	6.29	6.29	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	0.5	0.07	0.19	6.47	10.06	HGL ok
P-156	DI-156	DI-152	1.20	6.00	6.00	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	6.29	11.07	HGL ok
P-152	DI-152	MH-140	2.00	5.65	5.65	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	6.00	11.07	HGL ok
P-140	MH-140	DI-141	2.40	5.36	5.36	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	0.5	0.15	0.29	5.65	12.04	HGL ok
P-141	DI-141	DI-142	2.40	5.07	5.07	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	5.36	11.02	HGL ok
P-142	DI-142	DI-143	2.40	4.81	4.81	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	5.07	10.52	HGL ok
P-143	DI-143	MH-170	2.40	4.44	4.44	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	0.5	0.10	0.38	4.81	10.28	HGL ok
P-170	MH-170	MH-171	3.20	4.11	4.11	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	0.5	0.24	0.33	4.44	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.91	3.91	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	0.5	0.11	0.20	4.11	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.69	3.69	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	0.5	0.13	0.22	3.91	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.40**	**3.40**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	**0.5**	**0.15**	**0.29**	**3.69**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	4.11	4.11	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.11	10.61	HGL ok
P-175	DI-175	MH-171	1.20	4.11	4.11	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.11	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.91	3.91	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	3.99	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.91	3.91	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	3.98	10.00	HGL ok
P-178	TD-03	DI-179	0.53	4.12	6.23	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	6.96	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.69	3.69	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	1.3	1.0	0.38	0.43	4.12	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.81	6.78	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	6.92	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.69	3.69	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	1.3	1.0	0.09	0.11	3.81	9.25	HGL ok
P-115	B5 West	MH-116	1.20	7.45	7.45	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	7.52	10.00	HGL ok
P-116	MH-116	DI-117	1.20	7.17	7.17	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	0.5	0.11	0.27	7.45	11.99	HGL ok
P-117	DI-117	DI-118	1.20	6.82	6.82	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	7.17	11.71	HGL ok
P-118	DI-118	DI-113	1.20	6.45	6.45	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	6.82	11.30	HGL ok
P-113	DI-113	DI-114	1.20	5.60	5.60	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	6.45	11.30	HGL ok
P-114	DI-114	MH-170	1.20	4.44	4.44	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	5.60	10.75	HGL ok
P-110	B4 South	MH-111	1.20	6.77	6.77	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	6.80	10.00	HGL ok
P-111	MH-111	DI-112	1.20	6.64	6.64	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	0.5	0.05	0.13	6.77	11.99	HGL ok
P-112	DI-112	DI-113	1.20	6.45	6.45	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	1.3	1.0	0.08	0.19	6.64	11.71	HGL ok
P-120	DI-120	DI-121	1.00	5.18	5.18	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.18	7.10	HGL ok
P-121	DI-121	DI-122	1.00	5.11	5.11	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.06	5.18	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.99	4.99	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	1.3	1.0	0.04	0.12	5.11	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.85	4.85	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	0.5	0.10	0.14	4.99	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.66	4.66	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	4.85	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.85	4.85	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.85	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.99	4.99	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	5.06	10.00	HGL ok
P-130	DI-130	DI-131	1.00	5.04	5.04	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.05	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.99	4.99	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	5.04	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.87	4.87	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.12	4.99	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.78	4.78	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	0.5	0.06	0.08	4.87	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.66	4.66	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	4.78	9.44	HGL ok
P-135	MH-135	MH-170	2.00	4.44	4.44	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	0.5	0.09	0.22	4.66	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.87	4.87	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	4.90	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	5.55	5.55	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.55	11.02	HGL ok
P-145	MH-145	DI-146	1.20	5.42	5.42	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	5.55	10.87	HGL ok
P-146	DI-146	DI-147	1.20	5.15	5.15	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	5.42	10.52	HGL ok
P-147	DI-147	DI-143	1.20	4.81	4.81	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	5.15	10.28	HGL ok
P-148	B3 West	MH-145	1.20	5.55	5.55	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	5.59	10.00	HGL ok
P-167	DI-167	DI-159	1.00	6.36	6.36	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.37	7.48	HGL ok
P-159	DI-159	DI-150	1.00	6.30	6.30	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	6.36	7.70	HGL ok
P-150	DI-150	MH-151	1.00	6.27	6.27	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	6.30	9.06	HGL ok
P-151	MH-151	DI-152	1.60	6.00	6.00	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	6.27	10.06	HGL ok
P-153	B1	MH-151	1.60	6.27	6.27	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	6.33	10.00	HGL ok
P-157	B3 North	MH-155	1.20	6.47	6.47	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	6.51	10.00	HGL ok
P-166	B2 North	MH-163	1.20	6.10	6.10	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	6.16	10.00	HGL ok
P-163	MH-163	MH-140	1.20	5.65	5.65	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	6.10	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	9.98	9.98	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.00	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.97	9.97	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.98	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.79	9.79	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	0.5	0.07	0.19	9.97	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	9.50	9.50	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	9.79	11.07	HGL ok
P-152	DI-152	MH-140	2.00	9.15	9.15	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	9.50	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.86	8.86	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	0.5	0.15	0.29	9.15	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.57	8.57	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	8.86	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.31	8.31	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	8.57	10.52	HGL ok
P-143	DI-143	MH-170	2.40	7.94	7.94	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	0.5	0.10	0.38	8.31	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.61	7.61	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	0.5	0.24	0.33	7.94	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.41	7.41	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	0.5	0.11	0.20	7.61	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.19	7.19	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	0.5	0.13	0.22	7.41	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	**0.5**	**0.15**	**0.29**	**7.19**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.61	7.61	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.61	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.61	7.61	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.61	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.41	7.41	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	7.49	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.41	7.41	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	7.48	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.62	7.62	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	8.35	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.19	7.19	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	1.3	1.0	0.38	0.43	7.62	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.31	7.31	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	7.44	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.19	7.19	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	1.3	1.0	0.09	0.11	7.31	9.25	HGL ok
P-115	B5 West	MH-116	1.20	10.95	10.95	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	11.02	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.67	10.67	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	0.5	0.11	0.27	10.95	11.99	HGL ok
P-117	DI-117	DI-118	1.20	10.32	10.32	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	10.67	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.95	9.95	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	10.32	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	9.10	9.10	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	9.95	11.30	HGL ok
P-114	DI-114	MH-170	1.20	7.94	7.94	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	9.10	10.75	HGL ok
P-110	B4 South	MH-111	1.20	10.27	10.27	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.30	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.14	10.14	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	0.5	0.05	0.13	10.27	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.95	9.95	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	1.3	1.0	0.08	0.19	10.14	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.68	8.68	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.68	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.61	8.61	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.06	8.68	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.49	8.49	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	1.3	1.0	0.04	0.12	8.61	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.35	8.35	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	0.5	0.10	0.14	8.49	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.16	8.16	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	8.35	9.44	HGL ok
P-125	DI-125	DI-124	1.00	8.35	8.35	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.35	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.49	8.49	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	8.56	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.54	8.54	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.55	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.49	8.49	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	8.54	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.37	8.37	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.12	8.49	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.28	8.28	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	0.5	0.06	0.08	8.37	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.16	8.16	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	8.28	9.44	HGL ok
P-135	MH-135	MH-170	2.00	7.94	7.94	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	0.5	0.09	0.22	8.16	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.37	8.37	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	8.40	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.05	9.05	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.05	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.92	8.92	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	9.05	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.65	8.65	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	8.92	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.31	8.31	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	8.65	10.28	HGL ok
P-148	B3 West	MH-145	1.20	9.05	9.05	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	9.09	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	9.86	9.86	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.87	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.80	9.80	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	9.86	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.77	9.77	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	9.80	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	9.50	9.50	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	9.77	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.77	9.77	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	9.83	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	9.97	9.97	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	10.01	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.60	9.60	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	9.66	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.15	9.15	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	9.60	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	**HGL Check**
P-158	DI-158	DI-154	1.00	10.48	10.48	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.50	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.47	10.47	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.48	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.29	10.29	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	0.5	0.07	0.19	10.47	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.00	10.00	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	10.29	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	9.65	9.65	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	10.00	11.07	HGL ok
P-140	MH-140	DI-141	2.40	9.36	9.36	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	0.5	0.15	0.29	9.65	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.07	9.07	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	9.36	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.81	8.81	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	9.07	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.44	8.44	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	0.5	0.10	0.38	8.81	10.28	HGL ok
P-170	MH-170	MH-171	3.20	8.11	8.11	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	0.5	0.24	0.33	8.44	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.91	7.91	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	0.5	0.11	0.20	8.11	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.69	7.69	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	0.5	0.13	0.22	7.91	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	**0.5**	**0.15**	**0.29**	**7.69**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.11	8.11	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.11	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.11	8.11	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.11	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.91	7.91	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	7.99	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.91	7.91	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	7.98	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.12	8.12	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	8.85	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.69	7.69	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	1.3	1.0	0.38	0.43	8.12	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.81	7.81	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	7.94	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.69	7.69	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	1.3	1.0	0.09	0.11	7.81	9.25	HGL ok
P-115	B5 West	MH-116	1.20	11.45	11.45	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	11.52	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.17	11.17	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	0.5	0.11	0.27	11.45	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	10.82	10.82	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	11.17	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	10.45	10.45	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	10.82	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	9.60	9.60	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	10.45	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	8.44	8.44	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	9.60	10.75	HGL ok
P-110	B4 South	MH-111	1.20	10.77	10.77	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.80	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.64	10.64	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	0.5	0.05	0.13	10.77	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.45	10.45	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	1.3	1.0	0.08	0.19	10.64	11.71	HGL ok
P-120	DI-120	DI-121	1.00	9.18	9.18	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.18	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.11	9.11	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.06	9.18	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.99	8.99	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	1.3	1.0	0.04	0.12	9.11	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.85	8.85	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	0.5	0.10	0.14	8.99	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.66	8.66	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	8.85	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	8.85	8.85	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.85	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.99	8.99	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	9.06	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.04	9.04	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.05	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.99	8.99	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	9.04	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.87	8.87	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.12	8.99	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.78	8.78	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	0.5	0.06	0.08	8.87	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.66	8.66	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	8.78	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.44	8.44	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	0.5	0.09	0.22	8.66	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.87	8.87	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	8.90	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_i + H_i + H$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.55	9.55	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.55	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.42	9.42	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	9.55	10.87	HGL ok
P-146	DI-146	DI-147	1.20	9.15	9.15	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	9.42	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.81	8.81	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	9.15	10.28	HGL ok
P-148	B3 West	MH-145	1.20	9.55	9.55	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	9.59	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.36	10.36	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.37	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.30	10.30	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.36	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.27	10.27	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.30	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.00	10.00	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	10.27	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.27	10.27	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	10.33	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.47	10.47	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	10.51	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.10	10.10	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	10.16	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.65	9.65	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	10.10	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)	

No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	10.88	10.88	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.90	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.87	10.87	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.88	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.69	10.69	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	0.5	0.07	0.19	10.87	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.40	10.40	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	10.69	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.05	10.05	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	10.40	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	9.76	9.76	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	0.5	0.15	0.29	10.05	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.47	9.47	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	9.76	11.02	HGL ok
P-142	DI-142	DI-143	2.40	9.21	9.21	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	9.47	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.84	8.84	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	0.5	0.10	0.38	9.21	10.28	HGL ok
P-170	MH-170	MH-171	3.20	8.51	8.51	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	0.5	0.24	0.33	8.84	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.31	8.31	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	0.5	0.11	0.20	8.51	10.83	HGL ok
P-172	MH-172	MH-173	3.20	8.09	8.09	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	0.5	0.13	0.22	8.31	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	**0.5**	**0.15**	**0.29**	**8.09**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.51	8.51	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.51	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.51	8.51	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.51	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.31	8.31	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	8.39	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.31	8.31	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	8.38	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.52	8.52	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	9.25	10.50	HGL ok
P-179	DI-179	MH-173	1.00	8.09	8.09	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	1.3	1.0	0.38	0.43	8.52	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	8.21	8.21	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	8.34	10.50	HGL ok
P-181	DI-181	MH-173	1.00	8.09	8.09	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	1.3	1.0	0.09	0.11	8.21	9.25	HGL ok
P-115	B5 West	MH-116	1.20	11.85	11.85	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	11.92	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.57	11.57	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	0.5	0.11	0.27	11.85	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.22	11.22	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	11.57	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	10.85	10.85	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	11.22	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.00	10.00	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	10.85	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	8.84	8.84	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	10.00	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.17	11.17	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.20	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.04	11.04	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	0.5	0.05	0.13	11.17	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	10.85	10.85	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	1.3	1.0	0.08	0.19	11.04	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	9.58	9.58	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.58	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.51	9.51	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.06	9.58	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.39	9.39	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	1.3	1.0	0.04	0.12	9.51	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.25	9.25	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	0.5	0.10	0.14	9.39	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.06	9.06	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	9.25	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.25	9.25	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.25	10.67	HGL ok
P-126	B5 North	MH-123	1.20	9.39	9.39	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	9.46	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.44	9.44	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.45	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.39	9.39	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	9.44	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.27	9.27	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.12	9.39	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.18	9.18	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	0.5	0.06	0.08	9.27	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.06	9.06	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	9.18	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.84	8.84	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	0.5	0.09	0.22	9.06	10.15	HGL ok
P-136	B3 South	MH-133	1.20	9.27	9.27	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	9.30	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.95	9.95	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.95	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.82	9.82	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	9.95	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	9.55	9.55	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	9.82	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.21	9.21	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	9.55	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	9.95	9.95	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	9.99	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.76	10.76	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.77	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.70	10.70	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.76	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.67	10.67	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.70	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.40	10.40	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	10.67	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.67	10.67	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	10.73	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.87	10.87	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	10.91	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.50	10.50	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	10.56	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.05	10.05	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	10.50	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/23 | Sheet No.: 3 of 5
County: New Castle | Checked by: TMC | Date: 3/23/23 | Cm. No.: 20077
Segment: East Bank Blvd Outfall | Design Freq.: 100 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	11.38	11.38	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.40	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.37	11.37	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.38	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.19	11.19	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	0.5	0.07	0.19	11.37	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.90	10.90	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	11.19	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.55	10.55	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	10.90	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.26	10.26	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	0.5	0.15	0.29	10.55	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.97	9.97	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	10.26	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	9.71	9.71	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	9.97	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.34	9.34	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	0.5	0.10	0.38	9.71	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.01	9.01	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	0.5	0.24	0.33	9.34	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.81	8.81	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	0.5	0.11	0.20	9.01	10.83	HGL ok
P-172	MH-172	MH-173	3.20	8.59	8.59	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	0.5	0.13	0.22	8.81	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	**0.5**	**0.15**	**0.29**	**8.59**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	9.01	9.01	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.01	10.61	HGL ok
P-175	DI-175	MH-171	1.20	9.01	9.01	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.01	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.81	8.81	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	8.89	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.81	8.81	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	8.88	10.00	HGL ok
P-178	TD-03	DI-179	0.53	9.02	9.02	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	9.75	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	8.59	8.59	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	1.3	1.0	0.38	0.43	9.02	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	8.71	8.71	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	8.84	10.50	HGL ok
P-181	DI-181	MH-173	1.00	8.59	8.59	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	1.3	1.0	0.09	0.11	8.71	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.35	12.35	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	12.42	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.07	12.07	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	0.5	0.11	0.27	12.35	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.72	11.72	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	12.07	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.35	11.35	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	11.72	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.50	10.50	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	11.35	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	9.34	9.34	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	10.50	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.67	11.67	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.70	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.54	11.54	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	0.5	0.05	0.13	11.67	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.35	11.35	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	1.3	1.0	0.08	0.19	11.54	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.08	10.08	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.08	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.01	10.01	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.06	10.08	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.89	9.89	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	1.3	1.0	0.04	0.12	10.01	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.75	9.75	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	0.5	0.10	0.14	9.89	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.56	9.56	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	9.75	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.75	9.75	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.75	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	9.89	9.89	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	9.96	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.94	9.94	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.95	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.89	9.89	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	9.94	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.77	9.77	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.12	9.89	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.68	9.68	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	0.5	0.06	0.08	9.77	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.56	9.56	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	9.68	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.34	9.34	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	0.5	0.09	0.22	9.56	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	9.77	9.77	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	9.80	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.45	10.45	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.45	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.32	10.32	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	10.45	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.05	10.05	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	10.32	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.71	9.71	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	10.05	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.45	10.45	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	10.49	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.26	11.26	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.27	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.20	11.20	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.26	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.17	11.17	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.20	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.90	10.90	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	11.17	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.17	11.17	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	11.23	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.37	11.37	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.41	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.00	11.00	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	11.06	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.55	10.55	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	11.00	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t= H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	12.08	12.08	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.10	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.07	12.07	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.08	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.89	11.89	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	*0.5*	0.07	0.19	12.07	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.60	11.60	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	11.89	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.25	11.25	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	11.60	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.96	10.96	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	*0.5*	0.15	0.29	11.25	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	10.67	10.67	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	10.96	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.41	10.41	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	10.67	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.04	10.04	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	*0.5*	0.10	0.38	10.41	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.71	9.71	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	*0.5*	0.24	0.33	10.04	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.51	9.51	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.20	9.71	10.83	HGL ok
P-172	MH-172	MH-173	3.20	9.29	9.29	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	*0.5*	0.13	0.22	9.51	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	***0.5***	**0.15**	**0.29**	**9.29**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	9.71	9.71	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.71	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	9.71	9.71	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.71	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.51	9.51	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	9.59	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.51	9.51	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	9.58	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.72	9.72	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	10.45	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.29	9.29	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	*1.3*	1.0	0.38	0.43	9.72	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.41	9.41	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	9.54	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.29	9.29	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	*1.3*	1.0	0.09	0.11	9.41	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.05	13.05	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	13.12	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.77	12.77	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	*0.5*	0.11	0.27	13.05	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.42	12.42	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	12.77	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.05	12.05	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	12.42	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.20	11.20	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	12.05	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.04	10.04	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	11.20	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.37	12.37	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	12.40	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.24	12.24	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	*0.5*	0.05	0.13	12.37	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.05	12.05	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	*1.3*	1.0	0.08	0.19	12.24	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.78	10.78	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.78	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.71	10.71	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.06	10.78	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.59	10.59	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.12	10.71	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.45	10.45	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	*0.5*	0.10	0.14	10.59	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.26	10.26	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	10.45	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.45	10.45	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.45	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.59	10.59	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	10.66	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.64	10.64	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.65	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.59	10.59	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	10.64	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.47	10.47	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.12	10.59	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.38	10.38	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	*0.5*	0.06	0.08	10.47	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.26	10.26	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	10.38	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.04	10.04	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	*0.5*	0.09	0.22	10.26	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.47	10.47	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	10.50	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.15	11.15	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.15	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.02	11.02	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	11.15	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.75	10.75	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	11.02	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.41	10.41	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	10.75	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.15	11.15	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.19	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.96	11.96	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.97	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.90	11.90	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.96	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.87	11.87	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.90	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.60	11.60	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	11.87	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.87	11.87	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	11.93	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.07	12.07	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	12.11	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.70	11.70	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	11.76	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.25	11.25	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	11.70	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align; add $H_c = 0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.58	12.58	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.60	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.57	12.57	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.58	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.39	12.39	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	*0.5*	0.07	0.19	12.57	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.10	12.10	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	12.39	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.75	11.75	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	12.10	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.46	11.46	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	*0.5*	0.15	0.29	11.75	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.17	11.17	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	11.46	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.91	10.91	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	11.17	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.54	10.54	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	*0.5*	0.10	0.38	10.91	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.21	10.21	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	*0.5*	0.24	0.33	10.54	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.01	10.01	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.20	10.21	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.79	9.79	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	*0.5*	0.13	0.22	10.01	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	***0.5***	**0.15**	**0.29**	**9.79**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.21	10.21	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.21	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.21	10.21	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.21	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.01	10.01	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	10.09	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.01	10.01	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	10.08	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.22	10.22	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	10.95	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.79	9.79	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	*1.3*	1.0	0.38	0.43	10.22	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.91	9.91	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	10.04	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.79	9.79	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	*1.3*	1.0	0.09	0.11	9.91	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.55	13.55	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	13.62	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.27	13.27	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	*0.5*	0.11	0.27	13.55	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.92	12.92	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	13.27	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.55	12.55	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	12.92	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.70	11.70	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	12.55	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.54	10.54	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	11.70	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.87	12.87	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	12.90	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.74	12.74	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	*0.5*	0.05	0.13	12.87	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.55	12.55	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	*1.3*	1.0	0.08	0.19	12.74	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.28	11.28	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.28	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.21	11.21	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.06	11.28	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.09	11.09	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.12	11.21	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.95	10.95	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	*0.5*	0.10	0.14	11.09	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.76	10.76	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	10.95	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.95	10.95	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.95	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.09	11.09	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	11.16	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.14	11.14	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.15	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.09	11.09	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	11.14	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.97	10.97	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.12	11.09	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.88	10.88	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	*0.5*	0.06	0.08	10.97	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.76	10.76	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	10.88	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.54	10.54	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	*0.5*	0.09	0.22	10.76	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.97	10.97	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	11.00	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.65	11.65	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.65	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.52	11.52	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	11.65	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.25	11.25	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	11.52	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.91	10.91	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	11.25	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.65	11.65	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.69	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.46	12.46	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.47	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.40	12.40	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.46	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.37	12.37	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.40	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.10	12.10	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	12.37	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.37	12.37	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	12.43	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.57	12.57	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	12.61	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.20	12.20	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	12.26	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.75	11.75	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	12.20	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location No.	Location From	Location To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H=H_f+H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	13.88	13.88	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.90	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.87	13.87	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.88	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.69	13.69	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	*0.5*	0.07	0.19	13.87	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.40	13.40	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	13.69	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	13.05	13.05	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	13.40	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.76	12.76	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	*0.5*	0.15	0.29	13.05	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.47	12.47	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	12.76	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.21	12.21	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	12.47	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.84	11.84	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	*0.5*	0.10	0.38	12.21	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.51	11.51	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	*0.5*	0.24	0.33	11.84	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.31	11.31	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.20	11.51	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.09	11.09	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	*0.5*	0.13	0.22	11.31	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	***0.5***	**0.15**	**0.29**	**11.09**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.51	11.51	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.51	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.51	11.51	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.51	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.31	11.31	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	11.39	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.31	11.31	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	11.38	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.52	11.52	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	12.25	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.09	11.09	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	*1.3*	1.0	0.38	0.43	11.52	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.21	11.21	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	11.34	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.09	11.09	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	*1.3*	1.0	0.09	0.11	11.21	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.85	14.85	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	14.92	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.57	14.57	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	*0.5*	0.11	0.27	14.85	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.22	14.22	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	14.57	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.85	13.85	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	14.22	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.00	13.00	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	13.85	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.84	11.84	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	13.00	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.17	14.17	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	14.20	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.04	14.04	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	*0.5*	0.05	0.13	14.17	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.85	13.85	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	*1.3*	1.0	0.08	0.19	14.04	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.58	12.58	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.58	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.51	12.51	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.06	12.58	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.39	12.39	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.12	12.51	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.25	12.25	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	*0.5*	0.10	0.14	12.39	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.06	12.06	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	12.25	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.25	12.25	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.25	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.39	12.39	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	12.46	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.44	12.44	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.45	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.39	12.39	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	12.44	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.27	12.27	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.12	12.39	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.18	12.18	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	*0.5*	0.06	0.08	12.27	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.06	12.06	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	12.18	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.84	11.84	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	*0.5*	0.09	0.22	12.06	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.27	12.27	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	12.30	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.95	12.95	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.95	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.82	12.82	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	12.95	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.55	12.55	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	12.82	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.21	12.21	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	12.55	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.95	12.95	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	12.99	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.76	13.76	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.77	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.70	13.70	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.76	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.67	13.67	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.70	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.40	13.40	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	13.67	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.67	13.67	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	13.73	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.87	13.87	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	13.91	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.50	13.50	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	13.56	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.05	13.05	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	13.50	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\ adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\ adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	8.82	8.82	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.84	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	8.81	8.81	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.82	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	8.63	8.63	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	0.5	0.07	0.19	8.81	10.06	HGL ok
P-156	DI-156	DI-152	1.20	8.34	8.34	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	8.63	11.07	HGL ok
P-152	DI-152	MH-140	2.00	7.99	7.99	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	8.34	11.07	HGL ok
P-140	MH-140	DI-141	2.40	7.70	7.70	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	0.5	0.15	0.29	7.99	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.41	7.41	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	7.70	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.15	7.15	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	7.41	10.52	HGL ok
P-143	DI-143	MH-170	2.40	6.78	6.78	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	0.5	0.10	0.38	7.15	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.45	6.45	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	0.5	0.24	0.33	6.78	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.25	6.25	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	0.5	0.11	0.20	6.45	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.03	6.03	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	0.5	0.13	0.22	6.25	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	**0.5**	**0.15**	**0.29**	**6.03**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.45	6.45	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.45	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.45	6.45	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.45	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.25	6.25	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	6.33	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.25	6.25	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	6.32	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.46	6.46	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	7.19	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.03	6.03	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	1.3	1.0	0.38	0.43	6.46	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.15	6.78	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	6.92	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.03	6.03	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	1.3	1.0	0.09	0.11	6.15	9.25	HGL ok
P-115	B5 West	MH-116	1.20	9.79	9.79	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	9.86	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.51	9.51	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	0.5	0.11	0.27	9.79	11.99	HGL ok
P-117	DI-117	DI-118	1.20	9.16	9.16	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	9.51	11.71	HGL ok
P-118	DI-118	DI-113	1.20	8.79	8.79	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	9.16	11.30	HGL ok
P-113	DI-113	DI-114	1.20	7.94	7.94	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	8.79	11.30	HGL ok
P-114	DI-114	MH-170	1.20	6.78	6.78	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	7.94	10.75	HGL ok
P-110	B4 South	MH-111	1.20	9.11	9.11	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.14	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	8.98	8.98	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	0.5	0.05	0.13	9.11	11.99	HGL ok
P-112	DI-112	DI-113	1.20	8.79	8.79	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	1.3	1.0	0.08	0.19	8.98	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.52	7.52	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.52	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.45	7.45	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.06	7.52	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.33	7.33	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	1.3	1.0	0.04	0.12	7.45	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.19	7.19	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	0.5	0.10	0.14	7.33	8.91	HGL ok
P-124	DI-124	MH-135	1.60	7.00	7.00	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	7.19	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.19	7.19	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.19	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.33	7.33	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	7.40	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.38	7.38	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.39	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.33	7.33	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	7.38	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.21	7.21	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.12	7.33	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.12	7.12	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	0.5	0.06	0.08	7.21	8.91	HGL ok
P-134	DI-134	MH-135	1.60	7.00	7.00	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	7.12	9.44	HGL ok
P-135	MH-135	MH-170	2.00	6.78	6.78	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	0.5	0.09	0.22	7.00	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.21	7.21	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	7.24	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	7.89	7.89	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.89	11.02	HGL ok
P-145	MH-145	DI-146	1.20	7.76	7.76	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	7.89	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.49	7.49	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	7.76	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.15	7.15	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	7.49	10.28	HGL ok
P-148	B3 West	MH-145	1.20	7.89	7.89	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	7.93	10.00	HGL ok
P-167	DI-167	DI-159	1.00	8.70	8.70	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.71	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	8.64	8.64	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	8.70	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	8.61	8.61	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	8.64	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.34	8.34	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	8.61	10.06	HGL ok
P-153	B1	MH-151	1.60	8.61	8.61	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	8.67	10.00	HGL ok
P-157	B3 North	MH-155	1.20	8.81	8.81	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	8.85	10.00	HGL ok
P-166	B2 North	MH-163	1.20	8.44	8.44	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	8.50	10.00	HGL ok
P-163	MH-163	MH-140	1.20	7.99	7.99	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	8.44	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H=H_f+H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	9.02	9.02	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.04	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.01	9.01	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.02	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	8.83	8.83	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	0.5	0.07	0.19	9.01	10.06	HGL ok
P-156	DI-156	DI-152	1.20	8.54	8.54	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	8.83	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.19	8.19	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	8.54	11.07	HGL ok
P-140	MH-140	DI-141	2.40	7.90	7.90	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	0.5	0.15	0.29	8.19	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.61	7.61	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	7.90	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.35	7.35	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	7.61	10.52	HGL ok
P-143	DI-143	MH-170	2.40	6.98	6.98	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	0.5	0.10	0.38	7.35	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.65	6.65	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	0.5	0.24	0.33	6.98	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.45	6.45	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	0.5	0.11	0.20	6.65	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.23	6.23	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	0.5	0.13	0.22	6.45	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	**0.5**	**0.15**	**0.29**	**6.23**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.65	6.65	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.65	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.65	6.65	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.65	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.45	6.45	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	6.53	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.45	6.45	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	6.52	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.66	6.66	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	7.39	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.23	6.23	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	1.3	1.0	0.38	0.43	6.66	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.35	6.78	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	6.92	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.23	6.23	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	1.3	1.0	0.09	0.11	6.35	9.25	HGL ok
P-115	B5 West	MH-116	1.20	9.99	9.99	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	10.06	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.71	9.71	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	0.5	0.11	0.27	9.99	11.99	HGL ok
P-117	DI-117	DI-118	1.20	9.36	9.36	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	9.71	11.71	HGL ok
P-118	DI-118	DI-113	1.20	8.99	8.99	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	9.36	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.14	8.14	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	8.99	11.30	HGL ok
P-114	DI-114	MH-170	1.20	6.98	6.98	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	8.14	10.75	HGL ok
P-110	B4 South	MH-111	1.20	9.31	9.31	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.34	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.18	9.18	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	0.5	0.05	0.13	9.31	11.99	HGL ok
P-112	DI-112	DI-113	1.20	8.99	8.99	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	1.3	1.0	0.08	0.19	9.18	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.72	7.72	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.72	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.65	7.65	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.06	7.72	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.53	7.53	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	1.3	1.0	0.04	0.12	7.65	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.39	7.39	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	0.5	0.10	0.14	7.53	8.91	HGL ok
P-124	DI-124	MH-135	1.60	7.20	7.20	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	7.39	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.39	7.39	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.39	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.53	7.53	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	7.60	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.58	7.58	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.59	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.53	7.53	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	7.58	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.41	7.41	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.12	7.53	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.32	7.32	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	0.5	0.06	0.08	7.41	8.91	HGL ok
P-134	DI-134	MH-135	1.60	7.20	7.20	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	7.32	9.44	HGL ok
P-135	MH-135	MH-170	2.00	6.98	6.98	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	0.5	0.09	0.22	7.20	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.41	7.41	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	7.44	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.09	8.09	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.09	11.02	HGL ok
P-145	MH-145	DI-146	1.20	7.96	7.96	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	8.09	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.69	7.69	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	7.96	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.35	7.35	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	7.69	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.09	8.09	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	8.13	10.00	HGL ok
P-167	DI-167	DI-159	1.00	8.90	8.90	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.91	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	8.84	8.84	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	8.90	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	8.81	8.81	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	8.84	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.54	8.54	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	8.81	10.06	HGL ok
P-153	B1	MH-151	1.60	8.81	8.81	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	8.87	10.00	HGL ok
P-157	B3 North	MH-155	1.20	9.01	9.01	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	9.05	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	8.64	8.64	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	8.70	10.00	HGL ok
P-163	MH-163	MH-140	1.20	8.19	8.19	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	8.64	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)		

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add $Hc = 0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.52	12.52	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.54	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.51	12.51	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.52	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.33	12.33	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	*0.5*	0.07	0.19	12.51	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.04	12.04	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	12.33	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.69	11.69	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	12.04	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.40	11.40	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	*0.5*	0.15	0.29	11.69	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.11	11.11	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	11.40	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.85	10.85	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	11.11	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.48	10.48	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	*0.5*	0.10	0.38	10.85	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.15	10.15	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	*0.5*	0.24	0.33	10.48	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	9.95	9.95	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.20	10.15	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.73	9.73	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	*0.5*	0.13	0.22	9.95	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	***0.5***	**0.15**	**0.29**	**9.73**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.15	10.15	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.15	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.15	10.15	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.15	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.95	9.95	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	10.03	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.95	9.95	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	10.02	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.16	10.16	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	10.89	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.73	9.73	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	*1.3*	1.0	0.38	0.43	10.16	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.85	9.85	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	9.98	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.73	9.73	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	*1.3*	1.0	0.09	0.11	9.85	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.49	13.49	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	13.56	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.21	13.21	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	*0.5*	0.11	0.27	13.49	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.86	12.86	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	13.21	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.49	12.49	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	12.86	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.64	11.64	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	12.49	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.48	10.48	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	11.64	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.81	12.81	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	12.84	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.68	12.68	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	*0.5*	0.05	0.13	12.81	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.49	12.49	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	*1.3*	1.0	0.08	0.19	12.68	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.22	11.22	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.22	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.15	11.15	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.06	11.22	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.03	11.03	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.12	11.15	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.89	10.89	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	*0.5*	0.10	0.14	11.03	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.70	10.70	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	10.89	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.89	10.89	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.89	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.03	11.03	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	11.10	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.08	11.08	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.09	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.03	11.03	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	11.08	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.91	10.91	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.12	11.03	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.82	10.82	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	*0.5*	0.06	0.08	10.91	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.70	10.70	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	10.82	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.48	10.48	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	*0.5*	0.09	0.22	10.70	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.91	10.91	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	10.94	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.59	11.59	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.59	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.46	11.46	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	11.59	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.19	11.19	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	11.46	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.85	10.85	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	11.19	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.59	11.59	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.63	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.40	12.40	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.41	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.34	12.34	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.40	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.31	12.31	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.34	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.04	12.04	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	12.31	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.31	12.31	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	12.37	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.51	12.51	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	12.55	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.14	12.14	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	12.20	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.69	11.69	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	12.14	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 100 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_i +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	13.02	13.02	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.04	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.01	13.01	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.02	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.83	12.83	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	0.5	0.07	0.19	13.01	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.54	12.54	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	12.83	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.19	12.19	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	12.54	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.90	11.90	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	0.5	0.15	0.29	12.19	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.61	11.61	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	11.90	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.35	11.35	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	11.61	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.98	10.98	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	0.5	0.10	0.38	11.35	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.65	10.65	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	0.5	0.24	0.33	10.98	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.45	10.45	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	0.5	0.11	0.20	10.65	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.23	10.23	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	0.5	0.13	0.22	10.45	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	**0.5**	**0.15**	**0.29**	**10.23**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.65	10.65	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.65	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.65	10.65	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.65	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.45	10.45	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	10.53	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.45	10.45	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	10.52	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.66	10.66	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	11.39	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.23	10.23	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	1.3	1.0	0.38	0.43	10.66	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.35	10.35	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	10.48	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.23	10.23	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	1.3	1.0	0.09	0.11	10.35	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.99	13.99	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	14.06	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.71	13.71	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	0.5	0.11	0.27	13.99	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.36	13.36	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	13.71	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.99	12.99	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	13.36	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.14	12.14	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	12.99	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.98	10.98	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	12.14	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.31	13.31	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.34	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.18	13.18	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	0.5	0.05	0.13	13.31	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.99	12.99	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	1.3	1.0	0.08	0.19	13.18	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.72	11.72	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.72	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.65	11.65	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.06	11.72	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.53	11.53	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	1.3	1.0	0.04	0.12	11.65	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.39	11.39	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	0.5	0.10	0.14	11.53	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.20	11.20	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	11.39	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.39	11.39	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.39	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.53	11.53	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	11.60	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.58	11.58	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.59	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.53	11.53	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	11.58	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.41	11.41	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.12	11.53	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.32	11.32	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	0.5	0.06	0.08	11.41	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.20	11.20	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	11.32	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.98	10.98	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	0.5	0.09	0.22	11.20	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.41	11.41	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.44	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.09	12.09	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.09	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.96	11.96	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	12.09	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.69	11.69	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	11.96	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.35	11.35	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	11.69	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.09	12.09	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	12.13	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.90	12.90	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.91	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.84	12.84	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.90	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.81	12.81	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.84	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.54	12.54	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	12.81	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.81	12.81	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	12.87	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.01	13.01	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	13.05	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.64	12.64	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	12.70	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.19	12.19	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	12.64	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR   Date: 2/23/23   Sheet No.: 3 of 5
Checked by: TMC   Date: 3/23/23   Cm. No.: 20077
Design Freq.: 100 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	13.42	13.42	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.44	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.41	13.41	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.42	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.23	13.23	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	0.5	0.07	0.19	13.41	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.94	12.94	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	13.23	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.59	12.59	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	12.94	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.30	12.30	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	0.5	0.15	0.29	12.59	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.01	12.01	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	12.30	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.75	11.75	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	12.01	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.38	11.38	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	0.5	0.10	0.38	11.75	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.05	11.05	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	0.5	0.24	0.33	11.38	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.85	10.85	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	0.5	0.11	0.20	11.05	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.63	10.63	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	0.5	0.13	0.22	10.85	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	**0.5**	**0.15**	**0.29**	**10.63**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.05	11.05	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.05	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.05	11.05	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.05	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.85	10.85	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	10.93	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.85	10.85	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	10.92	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.06	11.06	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	11.79	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.63	10.63	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	1.3	1.0	0.38	0.43	11.06	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.75	10.75	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	10.88	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.63	10.63	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	1.3	1.0	0.09	0.11	10.75	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.39	14.39	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	14.46	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.11	14.11	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	0.5	0.11	0.27	14.39	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.76	13.76	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	14.11	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.39	13.39	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	13.76	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.54	12.54	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	13.39	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.38	11.38	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	12.54	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.71	13.71	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.74	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.58	13.58	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	0.5	0.05	0.13	13.71	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.39	13.39	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	1.3	1.0	0.08	0.19	13.58	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.12	12.12	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.12	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.05	12.05	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.06	12.12	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.93	11.93	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	1.3	1.0	0.04	0.12	12.05	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.79	11.79	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	0.5	0.10	0.14	11.93	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.60	11.60	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	11.79	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.79	11.79	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.79	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.93	11.93	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	12.00	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.98	11.98	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.99	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.93	11.93	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	11.98	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.81	11.81	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.12	11.93	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.72	11.72	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	0.5	0.06	0.08	11.81	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.60	11.60	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	11.72	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.38	11.38	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	0.5	0.09	0.22	11.60	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.81	11.81	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.84	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.49	12.49	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.49	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.36	12.36	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	12.49	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.09	12.09	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	12.36	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.75	11.75	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	12.09	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.49	12.49	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	12.53	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.30	13.30	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.31	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.24	13.24	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.30	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.21	13.21	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.24	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.94	12.94	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	13.21	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.21	13.21	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	13.27	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.41	13.41	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	13.45	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.04	13.04	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	13.10	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.59	12.59	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	13.04	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	13.92	13.92	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.94	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.91	13.91	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.92	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.73	13.73	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	*0.5*	0.07	0.19	13.91	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.44	13.44	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	13.73	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	13.09	13.09	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	13.44	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.80	12.80	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	*0.5*	0.15	0.29	13.09	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.51	12.51	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	12.80	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.25	12.25	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	12.51	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.88	11.88	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	*0.5*	0.10	0.38	12.25	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.55	11.55	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	*0.5*	0.24	0.33	11.88	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.35	11.35	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.20	11.55	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.13	11.13	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	*0.5*	0.13	0.22	11.35	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	***0.5***	**0.15**	**0.29**	**11.13**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.55	11.55	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.55	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.55	11.55	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.55	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.35	11.35	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	11.43	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.35	11.35	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	11.42	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.56	11.56	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	12.29	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.13	11.13	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	*1.3*	1.0	0.38	0.43	11.56	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.25	11.25	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	11.38	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.13	11.13	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	*1.3*	1.0	0.09	0.11	11.25	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.89	14.89	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	14.96	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.61	14.61	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	*0.5*	0.11	0.27	14.89	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.26	14.26	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	14.61	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.89	13.89	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	14.26	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.04	13.04	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	13.89	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.88	11.88	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	13.04	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.21	14.21	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	14.24	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.08	14.08	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	*0.5*	0.05	0.13	14.21	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.89	13.89	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	*1.3*	1.0	0.08	0.19	14.08	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.62	12.62	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.62	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.55	12.55	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.06	12.62	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.43	12.43	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.12	12.55	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.29	12.29	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	*0.5*	0.10	0.14	12.43	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.10	12.10	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	12.29	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.29	12.29	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.29	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.43	12.43	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	12.50	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.48	12.48	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.49	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.43	12.43	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	12.48	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.31	12.31	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.12	12.43	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.22	12.22	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	*0.5*	0.06	0.08	12.31	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.10	12.10	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	12.22	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.88	11.88	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	*0.5*	0.09	0.22	12.10	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.31	12.31	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	12.34	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.99	12.99	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.99	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.86	12.86	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	12.99	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.59	12.59	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	12.86	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.25	12.25	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	12.59	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.99	12.99	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	13.03	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.80	13.80	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.81	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.74	13.74	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.80	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.71	13.71	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.74	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.44	13.44	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	13.71	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.71	13.71	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	13.77	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.91	13.91	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	13.95	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.54	13.54	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	13.60	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.09	13.09	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	13.54	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3	of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077	
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)				

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	14.62	14.62	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.64	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	14.61	14.61	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.62	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	14.43	14.43	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	0.5	0.07	0.19	14.61	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	14.14	14.14	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	14.43	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	13.79	13.79	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	14.14	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	13.50	13.50	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	0.5	0.15	0.29	13.79	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	13.21	13.21	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	13.50	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.95	12.95	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	13.21	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.58	12.58	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	0.5	0.10	0.38	12.95	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.25	12.25	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	0.5	0.24	0.33	12.58	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	12.05	12.05	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	0.5	0.11	0.20	12.25	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.83	11.83	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	0.5	0.13	0.22	12.05	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	**0.5**	**0.15**	**0.29**	**11.83**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.25	12.25	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.25	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.25	12.25	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.25	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	12.05	12.05	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	12.13	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	12.05	12.05	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	12.12	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.26	12.26	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	12.99	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.83	11.83	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	1.3	1.0	0.38	0.43	12.26	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.95	11.95	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	12.08	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.83	11.83	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	1.3	1.0	0.09	0.11	11.95	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	15.59	15.59	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	15.66	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	15.31	15.31	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	0.5	0.11	0.27	15.59	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.96	14.96	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	15.31	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	14.59	14.59	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	14.96	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.74	13.74	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	14.59	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.58	12.58	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	13.74	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.91	14.91	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.94	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.78	14.78	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	0.5	0.05	0.13	14.91	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	14.59	14.59	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	1.3	1.0	0.08	0.19	14.78	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	13.32	13.32	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.32	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	13.25	13.25	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.06	13.32	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	13.13	13.13	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	1.3	1.0	0.04	0.12	13.25	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.99	12.99	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	0.5	0.10	0.14	13.13	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.80	12.80	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	12.99	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.99	12.99	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.99	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	13.13	13.13	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	13.20	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	13.18	13.18	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.19	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	13.13	13.13	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	13.18	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	13.01	13.01	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.12	13.13	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.92	12.92	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	0.5	0.06	0.08	13.01	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.80	12.80	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	12.92	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.58	12.58	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	0.5	0.09	0.22	12.80	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	13.01	13.01	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	13.04	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	13.69	13.69	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.69	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.56	13.56	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	13.69	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	13.29	13.29	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	13.56	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.95	12.95	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	13.29	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	13.69	13.69	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	13.73	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	14.50	14.50	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.51	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	14.44	14.44	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	14.50	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	14.41	14.41	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.44	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	14.14	14.14	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	14.41	10.06	HGL Too High!
P-153	B1	MH-151	1.60	14.41	14.41	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	14.47	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	14.61	14.61	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	14.65	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	14.24	14.24	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	14.30	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.79	13.79	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	14.24	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	15.12	15.12	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.14	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	15.11	15.11	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.12	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	14.93	14.93	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	*0.5*	0.07	0.19	15.11	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	14.64	14.64	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	14.93	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	14.29	14.29	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	14.64	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	14.00	14.00	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	*0.5*	0.15	0.29	14.29	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	13.71	13.71	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	14.00	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	13.45	13.45	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	13.71	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	13.08	13.08	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	*0.5*	0.10	0.38	13.45	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.75	12.75	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	*0.5*	0.24	0.33	13.08	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	12.55	12.55	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.20	12.75	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	12.33	12.33	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	*0.5*	0.13	0.22	12.55	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	***0.5***	**0.15**	**0.29**	**12.33**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.75	12.75	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.75	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.75	12.75	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.75	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	12.55	12.55	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	12.63	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	12.55	12.55	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	12.62	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.76	12.76	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	13.49	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	12.33	12.33	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	*1.3*	1.0	0.38	0.43	12.76	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	12.45	12.45	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	12.58	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	12.33	12.33	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	*1.3*	1.0	0.09	0.11	12.45	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	16.09	16.09	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	16.16	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	15.81	15.81	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	*0.5*	0.11	0.27	16.09	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	15.46	15.46	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	15.81	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	15.09	15.09	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	15.46	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	14.24	14.24	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	15.09	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	13.08	13.08	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	14.24	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	15.41	15.41	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	15.44	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	15.28	15.28	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	*0.5*	0.05	0.13	15.41	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	15.09	15.09	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	*1.3*	1.0	0.08	0.19	15.28	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	13.82	13.82	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.82	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	13.75	13.75	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.06	13.82	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	13.63	13.63	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.12	13.75	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	13.49	13.49	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	*0.5*	0.10	0.14	13.63	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	13.30	13.30	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	13.49	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	13.49	13.49	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.49	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	13.63	13.63	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	13.70	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	13.68	13.68	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.69	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	13.63	13.63	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	13.68	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	13.51	13.51	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.12	13.63	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	13.42	13.42	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	*0.5*	0.06	0.08	13.51	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	13.30	13.30	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	13.42	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	13.08	13.08	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	*0.5*	0.09	0.22	13.30	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	13.51	13.51	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	13.54	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	14.19	14.19	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.19	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	14.06	14.06	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	14.19	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	13.79	13.79	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	14.06	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	13.45	13.45	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	13.79	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	14.19	14.19	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	14.23	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	15.00	15.00	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.01	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	14.94	14.94	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	15.00	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	14.91	14.91	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.94	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	14.64	14.64	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	14.91	10.06	HGL Too High!
P-153	B1	MH-151	1.60	14.91	14.91	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	14.97	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	15.11	15.11	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	15.15	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	14.74	14.74	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	14.80	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	14.29	14.29	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	14.74	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by: TMC	Date: 3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.: 100	-year (50-year for sumps)		

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002{*}O{*}V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t= H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	16.42	16.42	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.44	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	16.41	16.41	15	1.2	1.0	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.42	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	16.23	16.23	18	5.5	3.1	89	51	0.0023	0.12	0	0.00	0.04	1.3	10.8	0.0	2.5	0.0	89	0.07	0.14	1.0	*0.5*	0.07	0.19	16.41	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	15.94	15.94	18	5.9	3.3	94	33	0.0027	0.09	0	0.00	0.04	16.9	0.0	0.0	3.1	0.1	89	0.10	0.20	1.0	1.0	0.20	0.29	16.23	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	15.59	15.59	30	18.8	3.8	85	97	0.0018	0.17	0	0.00	0.06	19.5	52.9	0.0	4.1	0.1	3	0.03	0.17	1.0	1.0	0.17	0.35	15.94	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	15.30	15.30	36	27.8	3.9	2	97	0.0015	0.14	0	0.00	0.06	72.3	53.5	0.0	3.8	0.1	85	0.16	0.30	1.0	*0.5*	0.15	0.29	15.59	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	15.01	15.01	36	28.1	4.0	1	96	0.0015	0.15	0	0.00	0.06	109.7	0.0	0.0	3.9	0.1	2	0.00	0.15	1.0	1.0	0.15	0.29	15.30	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	14.75	14.75	36	28.4	4.0	5	68	0.0015	0.10	0	0.00	0.06	112.1	0.0	0.0	4.0	0.1	1	0.00	0.15	1.0	1.0	0.15	0.25	15.01	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	14.38	14.38	36	35.1	5.0	86	115	0.0024	0.27	0	0.00	0.10	114.1	22.4	0.0	4.0	0.1	5	0.03	0.21	1.0	*0.5*	0.10	0.38	14.75	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	14.05	14.05	48	61.7	4.9	0	55	0.0016	0.09	0	0.00	0.09	174.8	83.1	56.2	5.0	0.1	86	0.26	0.49	1.0	*0.5*	0.24	0.33	14.38	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	13.85	13.85	48	62.8	5.0	0	50	0.0016	0.08	0	0.00	0.10	302.9	0.3	0.4	4.9	0.1	0	0.00	0.23	1.0	*0.5*	0.11	0.20	14.05	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	13.63	13.63	48	69.6	5.5	0	44	0.0020	0.09	0	0.00	0.12	313.9	9.2	8.5	5.0	0.1	0	0.00	0.25	1.0	*0.5*	0.13	0.22	13.85	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**73.9**	**5.9**	**0**	**64**	**0.0023**	**0.14**	**0**	**0.00**	**0.13**	**385.5**	**7.2**	**3.7**	**5.5**	**0.2**	**0**	**0.00**	**0.30**	**1.0**	***0.5***	**0.15**	**0.29**	**13.63**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	14.05	14.05	18	0.7	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.05	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	14.05	14.05	18	0.8	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.05	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	13.85	13.85	18	4.0	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	13.93	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	13.85	13.85	18	3.9	2.2	90	55	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.07	13.92	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	14.06	14.06	8	1.5	4.4	56	56	0.0116	0.65	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.73	14.79	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	13.63	13.63	15	3.0	2.4	90	30	0.0018	0.05	0	0.00	0.02	6.8	0.0	0.0	4.4	0.1	56	0.16	0.29	*1.3*	1.0	0.38	0.43	14.06	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	13.75	13.75	8	0.7	2.1	45	45	0.0026	0.12	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.13	13.88	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	13.63	13.63	15	2.1	1.7	90	30	0.0009	0.03	0	0.00	0.01	1.5	0.0	0.0	2.1	0.0	45	0.03	0.07	*1.3*	1.0	0.09	0.11	13.75	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	17.39	17.39	18	5.9	3.4	86	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	17.46	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	17.11	17.11	18	5.9	3.3	4	60	0.0027	0.16	0	0.00	0.04	20.0	0.0	0.0	3.4	0.1	86	0.12	0.22	1.0	*0.5*	0.11	0.27	17.39	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	16.76	16.76	18	6.4	3.6	89	71	0.0032	0.22	0	0.00	0.05	19.8	0.0	0.0	3.3	0.1	4	0.02	0.13	1.0	1.0	0.13	0.35	17.11	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	16.39	16.39	18	6.9	3.9	72	27	0.0037	0.10	0	0.00	0.06	23.2	0.0	0.0	3.6	0.1	89	0.14	0.27	1.0	1.0	0.27	0.37	16.76	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	15.54	15.54	18	11.8	6.7	25	41	0.0108	0.44	0	0.00	0.17	26.8	11.5	0.0	3.9	0.1	72	0.14	0.40	1.0	1.0	0.40	0.84	16.39	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	14.38	14.38	18	12.1	6.9	97	47	0.0113	0.53	0	0.00	0.18	79.3	0.0	0.0	6.7	0.2	25	0.21	0.64	1.0	1.0	0.64	1.17	15.54	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	16.71	16.71	18	4.0	2.3	86	17	0.0013	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	16.74	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	16.58	16.58	18	4.0	2.3	4	60	0.0012	0.07	0	0.00	0.02	9.2	0.0	0.0	2.3	0.0	86	0.06	0.10	1.0	*0.5*	0.05	0.13	16.71	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	16.39	16.39	18	4.5	2.6	19	71	0.0016	0.11	0	0.00	0.03	9.1	0.0	0.0	2.3	0.0	4	0.01	0.06	*1.3*	1.0	0.08	0.19	16.58	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	15.12	15.12	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.12	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	15.05	15.05	15	1.7	1.4	7	84	0.0006	0.05	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.06	15.12	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	14.93	14.93	15	2.7	2.2	14	56	0.0015	0.08	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	7	0.00	0.03	*1.3*	1.0	0.04	0.12	15.05	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	14.79	14.79	24	8.3	2.6	81	36	0.0011	0.04	0	0.00	0.03	5.8	19.7	0.0	3.3	0.1	81	0.11	0.20	1.0	*0.5*	0.10	0.14	14.93	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	14.60	14.60	24	9.2	2.9	90	31	0.0014	0.04	0	0.00	0.03	22.0	0.1	0.0	2.6	0.0	81	0.07	0.14	1.0	1.0	0.14	0.19	14.79	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	14.79	14.79	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.79	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	14.93	14.93	18	5.9	3.3	81	17	0.0027	0.05	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	*0.5*	0.02	0.07	15.00	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	14.98	14.98	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.99	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	14.93	14.93	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	14.98	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	14.81	14.81	15	2.6	2.1	14	56	0.0014	0.08	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.12	14.93	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	14.72	14.72	24	6.8	2.2	81	36	0.0008	0.03	0	0.00	0.02	5.6	10.8	0.0	2.5	0.0	81	0.06	0.11	1.0	*0.5*	0.06	0.08	14.81	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	14.60	14.60	24	7.5	2.4	90	31	0.0009	0.03	0	0.00	0.02	14.6	0.0	0.0	2.2	0.0	81	0.05	0.09	1.0	1.0	0.09	0.12	14.72	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	14.38	14.38	30	16.6	3.4	0	94	0.0014	0.13	0	0.00	0.04	17.9	26.8	0.0	2.9	0.0	90	0.09	0.18	1.0	*0.5*	0.09	0.22	14.60	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	14.81	14.81	18	4.4	2.5	81	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	14.84	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	15.49	15.49	15	0.5	0.4	12	55	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.49	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	15.36	15.36	18	4.8	2.7	7	39	0.0017	0.07	0	0.00	0.03	0.2	10.8	0.0	2.5	0.0	83	0.06	0.13	1.0	0.5	0.06	0.13	15.49	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	15.09	15.09	18	5.4	3.1	89	68	0.0023	0.15	0	0.00	0.04	12.8	0.0	0.0	2.7	0.0	7	0.01	0.09	1.3	1.0	0.11	0.27	15.36	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	14.75	14.75	18	6.3	3.6	86	25	0.0031	0.08	0	0.00	0.05	16.5	0.0	0.0	3.1	0.1	89	0.10	0.20	1.3	1.0	0.26	0.34	15.09	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	15.49	15.49	18	4.4	2.5	83	17	0.0015	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	15.53	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	16.30	16.30	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.31	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	16.24	16.24	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	16.30	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	16.21	16.21	15	2.0	1.6	10	24	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	16.24	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	15.94	15.94	24	12.9	4.1	3	51	0.0028	0.14	0	0.00	0.07	3.3	38.1	0.0	3.5	0.1	89	0.13	0.26	1.0	0.5	0.13	0.27	16.21	10.06	HGL Too High!
P-153	B1	MH-151	1.60	16.21	16.21	24	10.9	3.5	89	17	0.0020	0.03	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.06	16.27	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	16.41	16.41	18	4.4	2.5	89	18	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	16.45	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	16.04	16.04	18	3.8	2.2	90	50	0.0011	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	16.10	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	15.59	15.59	18	9.7	5.5	92	44	0.0073	0.32	0	0.00	0.12	8.4	0.0	8.4	2.2	0.0	90	0.05	0.19	1.3	0.5	0.13	0.45	16.04	10.50	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 3 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: East Bank Blvd Outfall | Storm Frequency: 200 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-158	DI-158	DI-154	3887	225	4112	0.09	0.91	0.09	0.09	6.0	0.00	4.01	**0.34**	15	100	0.012	0.000024	0.0053	4.2	**5.1**	2.0	0.82	6.82	**4.36**	3.83	Q ok
P-154	DI-154	MH-155	3023	31	3054	0.07	1.00	0.07	0.16	6.0	6.82	7.81	**1.22**	15	24	0.012	0.000302	0.0042	3.7	**4.5**	3.0	0.13	6.95	**3.73**	3.63	Q ok
P-155	MH-155	DI-156	1	0	1	0.00	1.00	0.00	0.72	6.0	6.95	7.74	**5.57**	18	51	0.012	0.002397	0.0039	4.0	**7.1**	4.5	0.19	7.14	3.53	3.33	Q ok
P-156	DI-156	DI-152	2725	0	2725	0.06	1.00	0.06	0.78	6.0	7.14	7.71	**6.03**	18	33	0.012	0.002806	0.0039	4.0	**7.1**	4.6	0.12	7.26	3.23	3.10	Q ok
P-152	DI-152	MH-140	3517	0	3517	0.08	1.00	0.08	2.52	6.0	7.26	7.64	**19.25**	**30**	97	0.012	0.001876	0.0040	5.7	**28.2**	6.3	0.26	7.52	3.00	2.61	Q ok
P-140	MH-140	DI-141	1	0	1	0.00	1.00	0.00	3.79	6.0	7.52	7.57	**28.67**	36	97	0.012	0.001574	0.0040	6.5	**45.8**	6.9	0.23	7.75	2.51	2.12	Q ok
P-141	DI-141	DI-142	3263	65	3328	0.08	1.00	0.08	3.87	6.0	7.75	7.46	**28.84**	36	96	0.012	0.001593	0.0040	6.4	**45.5**	6.9	0.23	7.98	2.02	1.64	Q ok
P-142	DI-142	DI-143	3699	195	3894	0.09	1.00	0.09	3.96	6.0	7.98	7.39	**29.23**	36	68	0.012	0.001637	0.0040	6.4	**45.5**	6.9	0.16	8.15	1.54	1.27	Q ok
P-143	DI-143	MH-170	5428	266	5694	0.13	1.00	0.13	4.93	6.0	8.15	7.36	**36.23**	36	115	0.012	0.002514	0.0040	6.5	**45.7**	7.2	0.26	8.41	1.17	0.71	Q ok
P-170	MH-170	MH-171	1	0	1	0.00	1.00	0.00	8.79	6.0	8.41	7.25	**63.73**	48	55	0.012	0.001677	0.0040	7.8	**98.4**	8.4	0.11	8.52	0.61	0.39	Q ok
P-171	MH-171	MH-172	1	0	1	0.00	1.00	0.00	8.99	6.0	8.52	7.22	**64.88**	48	50	0.012	0.001738	0.0040	7.8	**98.4**	8.4	0.10	8.62	0.29	0.09	Q ok
P-172	MH-172	MH-173	1	0	1	0.00	1.00	0.00	10.02	6.0	8.62	7.18	**71.91**	48	44	0.012	0.002136	0.0041	7.9	**99.5**	8.6	0.08	8.71	-0.01	-0.19	Q ok
P-173	MH-173	OUTFALL	1	0	1	0.00	1.00	0.00	10.68	6.0	8.71	7.15	**76.32**	**48**	64	0.012	0.002405	0.0041	7.9	**99.2**	8.8	0.12	8.83	-0.29	**-0.55**	Q ok
P-174	DI-174	MH-171	3578	530	4108	0.09	1.00	0.09	0.09	6.0	0.00	8.09	**0.76**	18	33	0.012	0.000045	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-175	DI-175	MH-171	4118	530	4648	0.11	1.00	0.11	0.11	6.0	0.00	8.09	**0.86**	18	33	0.012	0.000058	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-176	B4 North	MH-172	22780	0	22780	0.52	1.00	0.52	0.52	6.0	0.00	8.09	**4.23**	18	55	0.012	0.001382	0.0049	4.5	**8.0**	4.6	0.20	6.20	1.26	0.99	Q ok
P-177	B2 South	MH-172	21809	0	21809	0.50	1.00	0.50	0.50	6.0	0.00	8.09	**4.05**	18	55	0.012	0.001267	0.0049	4.5	**8.0**	4.5	0.21	6.21	1.26	0.99	Q ok
P-178	TD-03	DI-179	8687	0	8687	0.20	1.00	0.20	0.20	6.0	0.00	8.09	**1.61**	8	56	0.011	0.012762	0.0509	9.2	**3.2**	9.1	0.10	6.10	8.55	5.70	Q ok
P-179	DI-179	MH-173	6306	3055	9361	0.21	0.87	0.19	0.39	6.0	6.10	8.06	**3.12**	15	30	0.012	0.001985	0.0500	12.8	**15.6**	9.6	0.05	6.15	3.21	1.71	Q ok
P-180	TD-02	DI-181	4084	0	4084	0.09	1.00	0.09	0.09	6.0	0.00	8.09	**0.76**	8	45	0.011	0.002821	0.0500	9.1	**3.2**	7.5	0.10	6.10	8.50	6.25	Q ok
P-181	DI-181	MH-173	6222	2906	9128	0.21	0.88	0.18	0.28	6.0	6.10	8.06	**2.24**	15	30	0.012	0.001027	0.0500	12.8	**15.6**	8.9	0.06	6.16	3.21	1.71	Q ok
P-115	B5 West	MH-116	33468	0	33468	0.77	1.00	0.77	0.77	6.0	0.00	8.09	**6.22**	18	17	0.012	0.002983	0.0047	4.4	**7.8**	4.9	0.06	6.06	3.84	3.76	Q ok
P-116	MH-116	DI-117	1	0	1	0.00	1.00	0.00	0.77	6.0	6.06	8.06	**6.19**	18	60	0.012	0.002958	0.0050	4.6	**8.0**	5.1	0.20	6.26	3.66	3.36	Q ok
P-117	DI-117	DI-118	2919	167	3086	0.07	1.00	0.07	0.84	6.0	6.26	7.99	**6.70**	18	71	0.012	0.003467	0.0051	4.6	**8.1**	5.2	0.23	6.48	3.26	2.90	Q ok
P-118	DI-118	DI-113	2866	196	3062	0.07	1.00	0.07	0.91	6.0	6.48	7.92	**7.20**	18	27	0.012	0.004002	0.0048	4.5	**7.9**	5.1	0.09	6.57	2.80	2.67	Q ok
P-113	DI-113	DI-114	2882	195	3077	0.07	1.00	0.07	1.57	6.0	6.57	7.88	**12.39**	18	41	0.012	0.011853	0.0200	9.1	**16.1**	10.1	0.07	6.64	2.57	1.75	Q ok
P-114	DI-114	MH-170	1592	20	1612	0.04	1.00	0.04	1.61	6.0	6.64	7.88	**12.68**	18	47	0.012	0.012418	0.0200	9.1	**16.1**	10.2	0.08	6.72	1.65	0.71	Q ok
P-110	B4 South	MH-111	22751	0	22751	0.52	1.00	0.52	0.52	6.0	0.00	8.09	**4.23**	18	17	0.012	0.001379	0.0053	4.7	**8.3**	4.6	0.06	6.06	3.61	3.52	Q ok
P-111	MH-111	DI-112	1	0	1	0.00	1.00	0.00	0.52	6.0	6.06	8.06	**4.21**	18	60	0.012	0.001367	0.0050	4.6	**8.0**	4.5	0.22	6.28	3.42	3.12	Q ok
P-112	DI-112	DI-113	2877	164	3041	0.07	1.00	0.07	0.59	6.0	6.28	7.99	**4.73**	18	71	0.012	0.001726	0.0049	4.5	**8.0**	4.7	0.25	6.53	3.02	2.67	Q ok
P-120	DI-120	DI-121	2879	334	3213	0.07	1.00	0.07	0.07	6.0	0.00	8.09	**0.60**	15	22	0.012	0.000073	0.0032	3.2	**3.9**	2.3	0.16	6.16	**3.96**	3.89	Q ok
P-121	DI-121	DI-122	5403	1316	6719	0.15	1.00	0.15	0.23	6.0	6.16	8.02	**1.83**	15	84	0.012	0.000682	0.0031	3.2	**3.9**	3.1	0.45	6.62	3.79	3.53	Q ok
P-122	DI-122	MH-123	4404	1304	5708	0.13	0.97	0.13	0.35	6.0	6.62	7.88	**2.79**	15	56	0.012	0.001595	0.0030	3.1	**3.9**	3.4	0.27	6.89	3.43	3.26	Q ok
P-123	MH-123	DI-124	1	0	1	0.00	1.00	0.00	1.12	6.0	6.89	7.78	**8.70**	**24**	36	0.012	0.001259	0.0036	4.7	**14.7**	4.9	0.12	7.01	3.16	3.03	Q ok
P-124	DI-124	MH-135	3437	323	3760	0.09	1.00	0.09	1.24	6.0	7.01	7.74	**9.61**	**24**	31	0.012	0.001538	0.0048	5.4	**17.0**	5.5	0.09	7.11	2.93	2.78	Q ok
P-125	DI-125	DI-124	1587	15	1602	0.04	1.00	0.04	0.04	6.0	0.00	8.09	**0.30**	15	45	0.012	0.000018	0.0040	3.6	**4.4**	1.8	0.42	6.42	3.21	3.03	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 200	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-126	B5 North	MH-123	33276	0	33276	0.76	1.00	0.76	0.76	6.0	0.00	8.09	**6.18**	18	17	0.012	0.002949	0.0053	4.7	**8.3**	5.2	0.05	6.05	3.36	3.27	Q ok
P-130	DI-130	DI-131	2606	339	2945	0.07	1.00	0.07	0.07	6.0	0.00	8.09	**0.55**	15	22	0.012	0.000061	0.0032	3.2	**3.9**	2.3	0.16	6.16	**3.96**	3.89	Q ok
P-131	DI-131	DI-132	5203	1533	6736	0.15	0.97	0.15	0.22	6.0	6.16	8.02	**1.74**	15	83	0.012	0.000621	0.0030	3.1	**3.8**	3.0	0.46	6.62	3.79	3.54	Q ok
P-132	DI-132	MH-133	4517	1246	5763	0.13	0.98	0.13	0.35	6.0	6.62	7.88	**2.73**	15	56	0.012	0.001526	0.0030	3.1	**3.9**	3.4	0.27	6.89	3.44	3.27	Q ok
P-133	MH-133	DI-134	1	0	1	0.00	1.00	0.00	0.91	6.0	6.89	7.78	**7.08**	24	36	0.012	0.000835	0.0031	4.3	**13.5**	4.3	0.14	7.03	3.17	3.06	Q ok
P-134	DI-134	MH-135	4193	284	4477	0.10	1.00	0.10	1.01	6.0	7.03	7.74	**7.85**	**24**	31	0.012	0.001025	0.0035	4.6	**14.6**	4.7	0.11	7.14	2.96	2.85	Q ok
P-135	MH-135	MH-170	1	0	1	0.00	1.00	0.00	2.26	6.0	7.14	7.71	**17.38**	**30**	94	0.012	0.001530	0.0039	5.7	**27.9**	6.0	0.26	7.40	2.67	2.30	Q ok
P-136	B3 South	MH-133	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	8.09	**4.56**	18	17	0.012	0.001608	0.0047	4.4	**7.8**	4.6	0.06	6.06	3.36	3.28	Q ok
P-144	DI-144	MH-145	2618	65	2683	0.06	1.00	0.06	0.06	6.0	0.00	8.09	**0.50**	15	55	0.012	0.000051	0.0051	4.1	**5.0**	2.4	0.38	6.38	3.79	3.51	Q ok
P-145	MH-145	DI-146	1	0	1	0.00	1.00	0.00	0.63	6.0	6.38	7.95	**4.97**	18	39	0.012	0.001910	0.0049	4.5	**7.9**	4.8	0.14	6.51	3.41	3.22	Q ok
P-146	DI-146	DI-147	3675	195	3870	0.09	1.00	0.09	0.71	6.0	6.51	7.92	**5.66**	18	68	0.012	0.002470	0.0050	4.6	**8.0**	5.0	0.23	6.74	3.12	2.78	Q ok
P-147	DI-147	DI-143	5191	266	5457	0.13	1.00	0.13	0.84	6.0	6.74	7.85	**6.59**	18	25	0.012	0.003351	0.0052	4.6	**8.2**	5.2	0.08	6.82	2.68	2.55	Q ok
P-148	B3 West	MH-145	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	8.09	**4.56**	18	17	0.012	0.001608	0.0053	4.7	**8.3**	4.8	0.06	6.06	3.60	3.51	Q ok
P-167	DI-167	DI-159	3909	227	4136	0.09	0.91	0.09	0.09	6.0	6.00	4.01	**0.35**	15	18	0.012	0.000024	0.0033	3.3	**4.0**	2.0	0.15	6.15	4.29	4.23	Q ok
P-159	DI-159	DI-150	3909	227	4136	0.09	0.91	0.09	0.17	6.0	6.15	3.98	**0.69**	15	100	0.012	0.000096	0.0053	4.2	**5.1**	2.9	0.57	6.73	4.13	3.60	Q ok
P-150	DI-150	MH-151	3037	0	3037	0.07	1.00	0.07	0.24	6.0	0.00	8.09	**1.96**	15	24	0.012	0.000783	0.0042	3.7	**4.5**	3.6	0.11	6.11	3.50	3.40	Q ok
P-151	MH-151	DI-152	1	0	1	0.00	1.00	0.00	1.66	6.0	6.11	8.06	**13.35**	24	51	0.012	0.002969	0.0039	4.9	**15.3**	5.5	0.15	6.27	3.30	3.10	Q ok
P-153	B1	MH-151	61668	0	61668	1.42	1.00	1.42	1.42	6.0	0.00	8.09	**11.45**	24	17	0.012	0.002184	0.0100	7.8	**24.5**	7.6	0.04	6.04	3.57	3.40	Q ok
P-157	B3 North	MH-155	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	8.09	**4.56**	18	18	0.012	0.001608	0.0050	4.6	**8.0**	4.6	0.06	6.06	3.72	3.63	Q ok
P-166	B2 North	MH-163	21657	0	21657	0.50	1.00	0.50	0.50	6.0	0.00	8.09	**4.02**	18	50	0.012	0.001249	0.0050	4.6	**8.0**	4.5	0.18	6.18	3.62	3.37	Q ok
P-163	MH-163	MH-140	1	0	1	0.00	1.00	0.00	1.27	6.0	6.18	8.02	**10.18**	18	44	0.012	0.007998	0.0150	7.9	**13.9**	8.8	0.08	6.27	3.27	2.61	Q ok

KEY	
	Upsized from Semi-Final Design to have capacity for 50-yr design storm
	Optional Upsize-50-yr design storm results in >85% Full
	No Change from Semi-Final Design

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 200 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	6.58	6.58	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.59	7.70	HGL ok
P-154	DI-154	MH-155	1.00	6.56	6.56	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.58	9.06	HGL ok
P-155	MH-155	DI-156	1.20	6.36	6.36	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	0.5	0.07	0.20	6.56	10.06	HGL ok
P-156	DI-156	DI-152	1.20	6.05	6.05	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	6.36	11.07	HGL ok
P-152	DI-152	MH-140	2.00	5.67	5.67	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	6.05	11.07	HGL ok
P-140	MH-140	DI-141	2.40	5.35	5.35	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	0.5	0.16	0.32	5.67	12.04	HGL ok
P-141	DI-141	DI-142	2.40	5.03	5.03	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	5.35	11.02	HGL ok
P-142	DI-142	DI-143	2.40	4.75	4.75	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	5.03	10.52	HGL ok
P-143	DI-143	MH-170	2.40	4.33	4.33	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	0.5	0.11	0.41	4.75	10.28	HGL ok
P-170	MH-170	MH-171	3.20	3.97	3.97	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	0.5	0.27	0.36	4.33	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.76	3.76	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	0.5	0.12	0.21	3.97	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.52	3.52	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	0.5	0.14	0.24	3.76	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.20**	**3.20**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	**0.5**	**0.16**	**0.32**	**3.52**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	3.97	3.97	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.97	10.61	HGL ok
P-175	DI-175	MH-171	1.20	3.97	3.97	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	3.97	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.76	3.76	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	3.85	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.76	3.76	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	3.84	10.00	HGL ok
P-178	TD-03	DI-179	0.53	3.99	6.23	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	7.03	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.52	3.52	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	1.3	1.0	0.41	0.47	3.99	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.65	6.78	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	6.93	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.52	3.52	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	1.3	1.0	0.10	0.13	3.65	9.25	HGL ok
P-115	B5 West	MH-116	1.20	7.63	7.63	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	7.71	10.00	HGL ok
P-116	MH-116	DI-117	1.20	7.33	7.33	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	0.5	0.12	0.30	7.63	11.99	HGL ok
P-117	DI-117	DI-118	1.20	6.94	6.94	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	7.33	11.71	HGL ok
P-118	DI-118	DI-113	1.20	6.54	6.54	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	6.94	11.30	HGL ok
P-113	DI-113	DI-114	1.20	5.61	5.61	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	6.54	11.30	HGL ok
P-114	DI-114	MH-170	1.20	4.33	4.33	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	5.61	10.75	HGL ok
P-110	B4 South	MH-111	1.20	6.89	6.89	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	6.92	10.00	HGL ok
P-111	MH-111	DI-112	1.20	6.75	6.75	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	0.5	0.06	0.14	6.89	11.99	HGL ok
P-112	DI-112	DI-113	1.20	6.54	6.54	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	1.3	1.0	0.09	0.21	6.75	11.71	HGL ok
P-120	DI-120	DI-121	1.00	5.14	5.14	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.15	7.10	HGL ok
P-121	DI-121	DI-122	1.00	5.07	5.07	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.07	5.14	7.05	HGL ok
P-122	DI-122	MH-123	1.00	4.94	4.94	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	1.3	1.0	0.05	0.14	5.07	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.78	4.78	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	0.5	0.11	0.16	4.94	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.58	4.58	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	4.78	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.78	4.78	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.78	10.67	HGL ok
P-126	B5 North	MH-123	1.20	4.94	4.94	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	5.01	10.00	HGL ok
P-130	DI-130	DI-131	1.00	5.00	5.00	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.00	7.10	HGL ok
P-131	DI-131	DI-132	1.00	4.94	4.94	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	5.00	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.81	4.81	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.13	4.94	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.71	4.71	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	0.5	0.06	0.09	4.81	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.58	4.58	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	4.71	9.44	HGL ok
P-135	MH-135	MH-170	2.00	4.33	4.33	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	0.5	0.10	0.24	4.58	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.81	4.81	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	4.85	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	5.55	5.55	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.56	11.02	HGL ok
P-145	MH-145	DI-146	1.20	5.41	5.41	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	5.55	10.87	HGL ok
P-146	DI-146	DI-147	1.20	5.12	5.12	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	5.41	10.52	HGL ok
P-147	DI-147	DI-143	1.20	4.75	4.75	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	5.12	10.28	HGL ok
P-148	B3 West	MH-145	1.20	5.55	5.55	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	5.59	10.00	HGL ok
P-167	DI-167	DI-159	1.00	6.44	6.44	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.44	7.48	HGL ok
P-159	DI-159	DI-150	1.00	6.38	6.38	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	6.44	7.70	HGL ok
P-150	DI-150	MH-151	1.00	6.35	6.35	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	6.38	9.06	HGL ok
P-151	MH-151	DI-152	1.60	6.05	6.05	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	6.35	10.06	HGL ok
P-153	B1	MH-151	1.60	6.35	6.35	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	6.41	10.00	HGL ok
P-157	B3 North	MH-155	1.20	6.56	6.56	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	6.61	10.00	HGL ok
P-166	B2 North	MH-163	1.20	6.16	6.16	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	6.23	10.00	HGL ok
P-163	MH-163	MH-140	1.20	5.67	5.67	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	6.16	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	6.78	6.78	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.79	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	6.76	6.76	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.78	9.06	HGL ok
P-155	MH-155	DI-156	1.20	6.56	6.56	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	*0.5*	0.07	0.20	6.76	10.06	HGL ok
P-156	DI-156	DI-152	1.20	6.25	6.25	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	6.56	11.07	HGL ok
P-152	DI-152	MH-140	2.00	5.87	5.87	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	6.25	11.07	HGL ok
P-140	MH-140	DI-141	2.40	5.55	5.55	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	*0.5*	0.16	0.32	5.87	12.04	HGL ok
P-141	DI-141	DI-142	2.40	5.23	5.23	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	5.55	11.02	HGL ok
P-142	DI-142	DI-143	2.40	4.95	4.95	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	5.23	10.52	HGL ok
P-143	DI-143	MH-170	2.40	4.53	4.53	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	*0.5*	0.11	0.41	4.95	10.28	HGL ok
P-170	MH-170	MH-171	3.20	4.17	4.17	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	*0.5*	0.27	0.36	4.53	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.96	3.96	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	*0.5*	0.12	0.21	4.17	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.72	3.72	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	*0.5*	0.14	0.24	3.96	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.40**	**3.40**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	***0.5***	**0.16**	**0.32**	**3.72**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	4.17	4.17	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.17	10.61	HGL ok
P-175	DI-175	MH-171	1.20	4.17	4.17	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.17	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.96	3.96	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.09	4.05	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.96	3.96	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	4.04	10.00	HGL ok
P-178	TD-03	DI-179	0.53	4.19	6.23	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	7.03	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.72	3.72	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	*1.3*	1.0	0.41	0.47	4.19	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.85	6.78	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	6.93	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.72	3.72	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	*1.3*	1.0	0.10	0.13	3.85	9.25	HGL ok
P-115	B5 West	MH-116	1.20	7.83	7.83	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.02	0.07	7.91	10.00	HGL ok
P-116	MH-116	DI-117	1.20	7.53	7.53	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	*0.5*	0.12	0.30	7.83	11.99	HGL ok
P-117	DI-117	DI-118	1.20	7.14	7.14	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	7.53	11.71	HGL ok
P-118	DI-118	DI-113	1.20	6.74	6.74	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	7.14	11.30	HGL ok
P-113	DI-113	DI-114	1.20	5.81	5.81	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	6.74	11.30	HGL ok
P-114	DI-114	MH-170	1.20	4.53	4.53	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	5.81	10.75	HGL ok
P-110	B4 South	MH-111	1.20	7.09	7.09	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	7.12	10.00	HGL ok
P-111	MH-111	DI-112	1.20	6.95	6.95	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	*0.5*	0.06	0.14	7.09	11.99	HGL ok
P-112	DI-112	DI-113	1.20	6.74	6.74	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	*1.3*	1.0	0.09	0.21	6.95	11.71	HGL ok
P-120	DI-120	DI-121	1.00	5.34	5.34	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.35	7.10	HGL ok
P-121	DI-121	DI-122	1.00	5.27	5.27	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.07	5.34	7.05	HGL ok
P-122	DI-122	MH-123	1.00	5.14	5.14	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	*1.3*	1.0	0.05	0.14	5.27	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.98	4.98	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	*0.5*	0.11	0.16	5.14	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.78	4.78	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	4.98	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.98	4.98	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.98	10.67	HGL ok
P-126	B5 North	MH-123	1.20	5.14	5.14	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.02	0.07	5.21	10.00	HGL ok
P-130	DI-130	DI-131	1.00	5.20	5.20	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.20	7.10	HGL ok
P-131	DI-131	DI-132	1.00	5.14	5.14	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	5.20	7.15	HGL ok
P-132	DI-132	MH-133	1.00	5.01	5.01	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.13	5.14	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.91	4.91	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	*0.5*	0.06	0.09	5.01	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.78	4.78	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	4.91	9.44	HGL ok
P-135	MH-135	MH-170	2.00	4.53	4.53	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	*0.5*	0.10	0.24	4.78	10.15	HGL ok
P-136	B3 South	MH-133	1.20	5.01	5.01	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	5.05	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	5.75	5.75	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.76	11.02	HGL ok
P-145	MH-145	DI-146	1.20	5.61	5.61	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	5.75	10.87	HGL ok
P-146	DI-146	DI-147	1.20	5.32	5.32	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	5.61	10.52	HGL ok
P-147	DI-147	DI-143	1.20	4.95	4.95	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	5.32	10.28	HGL ok
P-148	B3 West	MH-145	1.20	5.75	5.75	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	5.79	10.00	HGL ok
P-167	DI-167	DI-159	1.00	6.64	6.64	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.64	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	6.58	6.58	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	6.64	7.70	HGL ok
P-150	DI-150	MH-151	1.00	6.55	6.55	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	6.58	9.06	HGL ok
P-151	MH-151	DI-152	1.60	6.25	6.25	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	6.55	10.06	HGL ok
P-153	B1	MH-151	1.60	6.55	6.55	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	6.61	10.00	HGL ok
P-157	B3 North	MH-155	1.20	6.76	6.76	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	6.81	10.00	HGL ok
P-166	B2 North	MH-163	1.20	6.36	6.36	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	6.43	10.00	HGL ok
P-163	MH-163	MH-140	1.20	5.87	5.87	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	6.36	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)	

No. (Location)	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	10.28	10.28	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.29	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.26	10.26	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.28	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.06	10.06	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	0.5	0.07	0.20	10.26	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	9.75	9.75	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	10.06	11.07	HGL ok
P-152	DI-152	MH-140	2.00	9.37	9.37	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	9.75	11.07	HGL ok
P-140	MH-140	DI-141	2.40	9.05	9.05	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	0.5	0.16	0.32	9.37	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.73	8.73	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	9.05	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.45	8.45	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	8.73	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.03	8.03	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	0.5	0.11	0.41	8.45	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.67	7.67	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	0.5	0.27	0.36	8.03	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.46	7.46	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	0.5	0.12	0.21	7.67	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.22	7.22	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	0.5	0.14	0.24	7.46	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	**0.5**	**0.16**	**0.32**	**7.22**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.67	7.67	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.67	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.67	7.67	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.67	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.46	7.46	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	7.55	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.46	7.46	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	7.54	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.69	7.69	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	8.49	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.22	7.22	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	1.3	1.0	0.41	0.47	7.69	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.35	7.35	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	7.49	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.22	7.22	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	1.3	1.0	0.10	0.13	7.35	9.25	HGL ok
P-115	B5 West	MH-116	1.20	11.33	11.33	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	11.41	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.03	11.03	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	0.5	0.12	0.30	11.33	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	10.64	10.64	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	11.03	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	10.24	10.24	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	10.64	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	9.31	9.31	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	10.24	11.30	HGL ok
P-114	DI-114	MH-170	1.20	8.03	8.03	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	9.31	10.75	HGL ok
P-110	B4 South	MH-111	1.20	10.59	10.59	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.62	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.45	10.45	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	0.5	0.06	0.14	10.59	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.24	10.24	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	1.3	1.0	0.09	0.21	10.45	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.84	8.84	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.85	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.77	8.77	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.07	8.84	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.64	8.64	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	1.3	1.0	0.05	0.14	8.77	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.48	8.48	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	0.5	0.11	0.16	8.64	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.28	8.28	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	8.48	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	8.48	8.48	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.48	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.64	8.64	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	8.71	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.70	8.70	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.70	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.64	8.64	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	8.70	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.51	8.51	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.13	8.64	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.41	8.41	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	0.5	0.06	0.09	8.51	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.28	8.28	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	8.41	9.44	HGL ok
P-135	MH-135	MH-170	2.00	8.03	8.03	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	0.5	0.10	0.24	8.28	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.51	8.51	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	8.55	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.25	9.25	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.26	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.11	9.11	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	9.25	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.82	8.82	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	9.11	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.45	8.45	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	8.82	10.28	HGL ok
P-148	B3 West	MH-145	1.20	9.25	9.25	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.29	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.14	10.14	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.14	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.08	10.08	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.14	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.05	10.05	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.08	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	9.75	9.75	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	10.05	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.05	10.05	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	10.11	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.26	10.26	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.31	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.86	9.86	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	9.93	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.37	9.37	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	9.86	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 200 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	10.78	10.78	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.79	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.76	10.76	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.78	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.56	10.56	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	*0.5*	0.07	0.20	10.76	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.25	10.25	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	10.56	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	9.87	9.87	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	10.25	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	9.55	9.55	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	*0.5*	0.16	0.32	9.87	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.23	9.23	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	9.55	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.95	8.95	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	9.23	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.53	8.53	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	*0.5*	0.11	0.41	8.95	10.28	HGL ok
P-170	MH-170	MH-171	3.20	8.17	8.17	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	*0.5*	0.27	0.36	8.53	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.96	7.96	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	*0.5*	0.12	0.21	8.17	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.72	7.72	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	*0.5*	0.14	0.24	7.96	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	***0.5***	**0.16**	**0.32**	**7.72**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.17	8.17	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.17	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.17	8.17	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.17	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.96	7.96	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.09	8.05	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.96	7.96	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	8.04	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.19	8.19	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	8.99	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.72	7.72	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	*1.3*	1.0	0.41	0.47	8.19	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.85	7.85	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	7.99	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.72	7.72	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	*1.3*	1.0	0.10	0.13	7.85	9.25	HGL ok
P-115	B5 West	MH-116	1.20	11.83	11.83	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.02	0.07	11.91	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.53	11.53	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	*0.5*	0.12	0.30	11.83	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.14	11.14	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	11.53	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	10.74	10.74	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	11.14	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	9.81	9.81	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	10.74	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	8.53	8.53	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	9.81	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.09	11.09	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	11.12	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.95	10.95	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	*0.5*	0.06	0.14	11.09	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	10.74	10.74	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	*1.3*	1.0	0.09	0.21	10.95	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	9.34	9.34	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.35	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.27	9.27	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.07	9.34	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.14	9.14	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	*1.3*	1.0	0.05	0.14	9.27	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.98	8.98	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	*0.5*	0.11	0.16	9.14	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.78	8.78	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	8.98	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	8.98	8.98	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.98	10.67	HGL ok
P-126	B5 North	MH-123	1.20	9.14	9.14	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.02	0.07	9.21	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.20	9.20	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.20	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.14	9.14	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	9.20	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.01	9.01	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.13	9.14	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.91	8.91	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	*0.5*	0.06	0.09	9.01	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.78	8.78	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	8.91	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.53	8.53	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	*0.5*	0.10	0.24	8.78	10.15	HGL ok
P-136	B3 South	MH-133	1.20	9.01	9.01	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	9.05	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = Hf + Hf adj	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{f\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.75	9.75	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.76	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.61	9.61	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	9.75	10.87	HGL ok
P-146	DI-146	DI-147	1.20	9.32	9.32	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	9.61	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	8.95	8.95	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	9.32	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	9.75	9.75	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.79	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.64	10.64	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.64	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.58	10.58	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.64	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.55	10.55	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.58	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.25	10.25	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	10.55	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.55	10.55	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	10.61	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.76	10.76	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.81	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.36	10.36	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	10.43	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.87	9.87	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	10.36	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 200 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	11.18	11.18	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.19	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.16	11.16	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.18	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.96	10.96	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	0.5	0.07	0.20	11.16	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.65	10.65	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	10.96	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.27	10.27	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	10.65	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	9.95	9.95	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	0.5	0.16	0.32	10.27	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.63	9.63	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	9.95	11.02	HGL ok
P-142	DI-142	DI-143	2.40	9.35	9.35	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	9.63	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	8.93	8.93	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	0.5	0.11	0.41	9.35	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	8.57	8.57	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	0.5	0.27	0.36	8.93	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.36	8.36	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	0.5	0.12	0.21	8.57	10.83	HGL ok
P-172	MH-172	MH-173	3.20	8.12	8.12	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	0.5	0.14	0.24	8.36	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	**0.5**	**0.16**	**0.32**	**8.12**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.57	8.57	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.57	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.57	8.57	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.57	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.36	8.36	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	8.45	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.36	8.36	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	8.44	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.59	8.59	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	9.39	10.50	HGL ok
P-179	DI-179	MH-173	1.00	8.12	8.12	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	1.3	1.0	0.41	0.47	8.59	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	8.25	8.25	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	8.39	10.50	HGL ok
P-181	DI-181	MH-173	1.00	8.12	8.12	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	1.3	1.0	0.10	0.13	8.25	9.25	HGL ok
P-115	B5 West	MH-116	1.20	12.23	12.23	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	12.31	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.93	11.93	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	0.5	0.12	0.30	12.23	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.54	11.54	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	11.93	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.14	11.14	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	11.54	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.21	10.21	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	11.14	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	8.93	8.93	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	10.21	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.49	11.49	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.52	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.35	11.35	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	0.5	0.06	0.14	11.49	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.14	11.14	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	1.3	1.0	0.09	0.21	11.35	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	9.74	9.74	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.75	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.67	9.67	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.07	9.74	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.54	9.54	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	1.3	1.0	0.05	0.14	9.67	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.38	9.38	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	0.5	0.11	0.16	9.54	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.18	9.18	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	9.38	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.38	9.38	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.38	10.67	HGL ok
P-126	B5 North	MH-123	1.20	9.54	9.54	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	9.61	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.60	9.60	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.60	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.54	9.54	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	9.60	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.41	9.41	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.13	9.54	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.31	9.31	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	0.5	0.06	0.09	9.41	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.18	9.18	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	9.31	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.93	8.93	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	0.5	0.10	0.24	9.18	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	9.41	9.41	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.45	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.15	10.15	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.16	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.01	10.01	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	10.15	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	9.72	9.72	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	10.01	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.35	9.35	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	9.72	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.15	10.15	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.19	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.04	11.04	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.04	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.98	10.98	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.04	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.95	10.95	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.98	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.65	10.65	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	10.95	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.95	10.95	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	11.01	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.16	11.16	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.21	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.76	10.76	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	10.83	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.27	10.27	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	10.76	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 200 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	11.68	11.68	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.69	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.66	11.66	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.68	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.46	11.46	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	0.5	0.07	0.20	11.66	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.15	11.15	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	11.46	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.77	10.77	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	11.15	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.45	10.45	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	0.5	0.16	0.32	10.77	12.04	HGL ok
P-141	DI-141	DI-142	2.40	10.13	10.13	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	10.45	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	9.85	9.85	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	10.13	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.43	9.43	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	0.5	0.11	0.41	9.85	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.07	9.07	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	0.5	0.27	0.36	9.43	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.86	8.86	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	0.5	0.12	0.21	9.07	10.83	HGL ok
P-172	MH-172	MH-173	3.20	8.62	8.62	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	0.5	0.14	0.24	8.86	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	**0.5**	**0.16**	**0.32**	**8.62**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	9.07	9.07	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.07	10.61	HGL ok
P-175	DI-175	MH-171	1.20	9.07	9.07	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.07	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.86	8.86	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	8.95	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.86	8.86	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	8.94	10.00	HGL ok
P-178	TD-03	DI-179	0.53	9.09	9.09	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	9.89	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	8.62	8.62	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	1.3	1.0	0.41	0.47	9.09	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	8.75	8.75	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	8.89	10.50	HGL ok
P-181	DI-181	MH-173	1.00	8.62	8.62	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	1.3	1.0	0.10	0.13	8.75	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.73	12.73	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	12.81	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.43	12.43	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	0.5	0.12	0.30	12.73	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.04	12.04	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	12.43	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.64	11.64	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	12.04	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.71	10.71	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	11.64	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	9.43	9.43	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	10.71	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.99	11.99	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.02	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.85	11.85	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	0.5	0.06	0.14	11.99	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.64	11.64	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	1.3	1.0	0.09	0.21	11.85	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.24	10.24	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.25	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.17	10.17	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.07	10.24	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.04	10.04	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	1.3	1.0	0.05	0.14	10.17	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.88	9.88	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	0.5	0.11	0.16	10.04	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.68	9.68	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	9.88	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.88	9.88	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.88	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.04	10.04	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	10.11	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.10	10.10	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.10	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.04	10.04	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	10.10	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.91	9.91	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.13	10.04	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.81	9.81	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	0.5	0.06	0.09	9.91	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.68	9.68	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	9.81	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.43	9.43	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	0.5	0.10	0.24	9.68	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	9.91	9.91	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.95	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.65	10.65	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.66	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.51	10.51	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	10.65	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.22	10.22	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	10.51	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.85	9.85	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	10.22	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.65	10.65	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.69	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.54	11.54	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.54	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.48	11.48	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.54	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.45	11.45	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.48	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.15	11.15	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	11.45	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.45	11.45	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	11.51	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.66	11.66	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.71	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.26	11.26	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	11.33	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.77	10.77	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	11.26	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 200 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.38	12.38	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.39	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.36	12.36	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.38	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.16	12.16	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	0.5	0.07	0.20	12.36	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.85	11.85	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	12.16	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.47	11.47	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	11.85	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.15	11.15	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	0.5	0.16	0.32	11.47	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	10.83	10.83	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	11.15	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.55	10.55	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	10.83	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.13	10.13	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	0.5	0.11	0.41	10.55	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.77	9.77	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	0.5	0.27	0.36	10.13	11.16	HGL ok
P-171	MH-171	MH-172	3.20	9.56	9.56	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	0.5	0.12	0.21	9.77	10.83	HGL ok
P-172	MH-172	MH-173	3.20	9.32	9.32	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	0.5	0.14	0.24	9.56	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	**0.5**	**0.16**	**0.32**	**9.32**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	9.77	9.77	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.77	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	9.77	9.77	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.77	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.56	9.56	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	9.65	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.56	9.56	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	9.64	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.79	9.79	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	10.59	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.32	9.32	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	1.3	1.0	0.41	0.47	9.79	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.45	9.45	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	9.59	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.32	9.32	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	1.3	1.0	0.10	0.13	9.45	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.43	13.43	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	13.51	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.13	13.13	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	0.5	0.12	0.30	13.43	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.74	12.74	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	13.13	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.34	12.34	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	12.74	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.41	11.41	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	12.34	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.13	10.13	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	11.41	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.69	12.69	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.72	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.55	12.55	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	0.5	0.06	0.14	12.69	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.34	12.34	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	1.3	1.0	0.09	0.21	12.55	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.94	10.94	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.95	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.87	10.87	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.07	10.94	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.74	10.74	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	1.3	1.0	0.05	0.14	10.87	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.58	10.58	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	0.5	0.11	0.16	10.74	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.38	10.38	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	10.58	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.58	10.58	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.58	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.74	10.74	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	10.81	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.80	10.80	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.80	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.74	10.74	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	10.80	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.61	10.61	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.13	10.74	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.51	10.51	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	0.5	0.06	0.09	10.61	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.38	10.38	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	10.51	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.13	10.13	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	0.5	0.10	0.24	10.38	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.61	10.61	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.65	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.35	11.35	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.36	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.21	11.21	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	11.35	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.92	10.92	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	11.21	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.55	10.55	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	10.92	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.35	11.35	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.39	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.24	12.24	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.24	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.18	12.18	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.24	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.15	12.15	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.18	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.85	11.85	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	12.15	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.15	12.15	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	12.21	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.36	12.36	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.41	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.96	11.96	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	12.03	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.47	11.47	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	11.96	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add $Hc = 0.002^*O^*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.88	12.88	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.89	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.86	12.86	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.88	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.66	12.66	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	0.5	0.07	0.20	12.86	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.35	12.35	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	12.66	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.97	11.97	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	12.35	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.65	11.65	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	0.5	0.16	0.32	11.97	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.33	11.33	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	11.65	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.05	11.05	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	11.33	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.63	10.63	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	0.5	0.11	0.41	11.05	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.27	10.27	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	0.5	0.27	0.36	10.63	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.06	10.06	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	0.5	0.12	0.21	10.27	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.82	9.82	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	0.5	0.14	0.24	10.06	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	**0.5**	**0.16**	**0.32**	**9.82**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.27	10.27	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.27	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.27	10.27	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.27	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.06	10.06	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	10.15	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.06	10.06	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	10.14	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.29	10.29	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	11.09	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.82	9.82	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	1.3	1.0	0.41	0.47	10.29	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.95	9.95	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	10.09	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.82	9.82	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	1.3	1.0	0.10	0.13	9.95	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.93	13.93	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	14.01	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.63	13.63	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	0.5	0.12	0.30	13.93	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.24	13.24	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	13.63	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.84	12.84	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	13.24	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.91	11.91	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	12.84	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.63	10.63	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	11.91	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.19	13.19	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.22	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.05	13.05	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	0.5	0.06	0.14	13.19	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.84	12.84	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	1.3	1.0	0.09	0.21	13.05	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.44	11.44	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.45	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.37	11.37	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.07	11.44	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.24	11.24	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	1.3	1.0	0.05	0.14	11.37	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.08	11.08	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	0.5	0.11	0.16	11.24	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.88	10.88	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	11.08	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.08	11.08	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.08	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.24	11.24	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	11.31	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.30	11.30	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.30	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.24	11.24	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	11.30	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.11	11.11	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.13	11.24	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.01	11.01	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	0.5	0.06	0.09	11.11	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.88	10.88	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	11.01	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.63	10.63	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	0.5	0.10	0.24	10.88	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.11	11.11	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.15	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.85	11.85	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.86	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.71	11.71	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	11.85	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.42	11.42	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	11.71	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.05	11.05	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	11.42	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.85	11.85	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.89	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.74	12.74	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.74	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.68	12.68	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.74	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.65	12.65	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.68	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.35	12.35	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	12.65	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.65	12.65	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	12.71	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.86	12.86	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.91	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.46	12.46	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	12.53	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.97	11.97	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	12.46	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)		

No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add $Hc = 0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	14.18	14.18	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.19	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	14.16	14.16	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.18	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.96	13.96	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	0.5	0.07	0.20	14.16	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.65	13.65	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	13.96	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	13.27	13.27	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	13.65	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.95	12.95	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	0.5	0.16	0.32	13.27	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.63	12.63	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	12.95	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.35	12.35	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	12.63	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.93	11.93	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	0.5	0.11	0.41	12.35	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.57	11.57	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	0.5	0.27	0.36	11.93	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.36	11.36	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	0.5	0.12	0.21	11.57	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.12	11.12	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	0.5	0.14	0.24	11.36	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	**0.5**	**0.16**	**0.32**	**11.12**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.57	11.57	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.57	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.57	11.57	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.57	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.36	11.36	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	11.45	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.36	11.36	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	11.44	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.59	11.59	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	12.39	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.12	11.12	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	1.3	1.0	0.41	0.47	11.59	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.25	11.25	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	11.39	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.12	11.12	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	1.3	1.0	0.10	0.13	11.25	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	15.23	15.23	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	15.31	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.93	14.93	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	0.5	0.12	0.30	15.23	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.54	14.54	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	14.93	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	14.14	14.14	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	14.54	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.21	13.21	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	14.14	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.93	11.93	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	13.21	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.49	14.49	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.52	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.35	14.35	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	0.5	0.06	0.14	14.49	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	14.14	14.14	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	1.3	1.0	0.09	0.21	14.35	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.74	12.74	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.75	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.67	12.67	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.07	12.74	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.54	12.54	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	1.3	1.0	0.05	0.14	12.67	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.38	12.38	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	0.5	0.11	0.16	12.54	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.18	12.18	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	12.38	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.38	12.38	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.38	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.54	12.54	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	12.61	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.60	12.60	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.60	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.54	12.54	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	12.60	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.41	12.41	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.13	12.54	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.31	12.31	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	0.5	0.06	0.09	12.41	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.18	12.18	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	12.31	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.93	11.93	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	0.5	0.10	0.24	12.18	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.41	12.41	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.45	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	13.15	13.15	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.16	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.01	13.01	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	13.15	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.72	12.72	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	13.01	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.35	12.35	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	12.72	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	13.15	13.15	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	13.19	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	14.04	14.04	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.04	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.98	13.98	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	14.04	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.95	13.95	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.98	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.65	13.65	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	13.95	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.95	13.95	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	14.01	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	14.16	14.16	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	14.21	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.76	13.76	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	13.83	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.27	13.27	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	13.76	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 200 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	9.12	9.12	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.13	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.10	9.10	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.12	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	8.90	8.90	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	*0.5*	0.07	0.20	9.10	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	8.59	8.59	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	8.90	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.21	8.21	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	8.59	11.07	HGL ok
P-140	MH-140	DI-141	2.40	7.89	7.89	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	*0.5*	0.16	0.32	8.21	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.57	7.57	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	7.89	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.29	7.29	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	7.57	10.52	HGL ok
P-143	DI-143	MH-170	2.40	6.87	6.87	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	*0.5*	0.11	0.41	7.29	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.51	6.51	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	*0.5*	0.27	0.36	6.87	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.30	6.30	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	*0.5*	0.12	0.21	6.51	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.06	6.06	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	*0.5*	0.14	0.24	6.30	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	***0.5***	**0.16**	**0.32**	**6.06**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.51	6.51	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.51	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.51	6.51	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.51	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.30	6.30	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.09	6.39	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.30	6.30	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	6.38	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.53	6.53	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	7.33	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.06	6.06	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	*1.3*	1.0	0.41	0.47	6.53	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.19	6.78	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	6.93	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.06	6.06	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	*1.3*	1.0	0.10	0.13	6.19	9.25	HGL ok
P-115	B5 West	MH-116	1.20	10.17	10.17	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.02	0.07	10.25	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	9.87	9.87	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	*0.5*	0.12	0.30	10.17	11.99	HGL ok
P-117	DI-117	DI-118	1.20	9.48	9.48	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	9.87	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.08	9.08	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	9.48	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.15	8.15	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	9.08	11.30	HGL ok
P-114	DI-114	MH-170	1.20	6.87	6.87	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	8.15	10.75	HGL ok
P-110	B4 South	MH-111	1.20	9.43	9.43	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	9.46	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.29	9.29	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	*0.5*	0.06	0.14	9.43	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.08	9.08	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	*1.3*	1.0	0.09	0.21	9.29	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.68	7.68	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.69	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.61	7.61	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.07	7.68	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.48	7.48	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	*1.3*	1.0	0.05	0.14	7.61	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.32	7.32	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	*0.5*	0.11	0.16	7.48	8.91	HGL ok
P-124	DI-124	MH-135	1.60	7.12	7.12	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	7.32	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.32	7.32	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.32	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.48	7.48	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.02	0.07	7.55	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.54	7.54	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.54	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.48	7.48	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	7.54	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.35	7.35	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.13	7.48	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.25	7.25	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	*0.5*	0.06	0.09	7.35	8.91	HGL ok
P-134	DI-134	MH-135	1.60	7.12	7.12	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	7.25	9.44	HGL ok
P-135	MH-135	MH-170	2.00	6.87	6.87	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	*0.5*	0.10	0.24	7.12	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.35	7.35	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	7.39	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = Hf + Hf adj	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{f\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.09	8.09	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.10	11.02	HGL ok
P-145	MH-145	DI-146	1.20	7.95	7.95	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	8.09	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.66	7.66	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	7.95	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.29	7.29	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	7.66	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.09	8.09	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	8.13	10.00	HGL ok
P-167	DI-167	DI-159	1.00	8.98	8.98	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.98	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	8.92	8.92	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	8.98	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	8.89	8.89	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	8.92	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.59	8.59	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	8.89	10.06	HGL ok
P-153	B1	MH-151	1.60	8.89	8.89	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	8.95	10.00	HGL ok
P-157	B3 North	MH-155	1.20	9.10	9.10	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.15	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	8.70	8.70	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	8.77	10.00	HGL ok
P-163	MH-163	MH-140	1.20	8.21	8.21	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	8.70	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR   Date: 2/23/23   Sheet No.: 3 of 5
Checked by: TMC   Date: 3/23/23   Cm. No.: 20077
Design Freq.: 200 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	9.32	9.32	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.33	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.30	9.30	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.32	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.10	9.10	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	0.5	0.07	0.20	9.30	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	8.79	8.79	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	9.10	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.41	8.41	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	8.79	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.09	8.09	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	0.5	0.16	0.32	8.41	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.77	7.77	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	8.09	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.49	7.49	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	7.77	10.52	HGL ok
P-143	DI-143	MH-170	2.40	7.07	7.07	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	0.5	0.11	0.41	7.49	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.71	6.71	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	0.5	0.27	0.36	7.07	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.50	6.50	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	0.5	0.12	0.21	6.71	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.26	6.26	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	0.5	0.14	0.24	6.50	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	**0.5**	**0.16**	**0.32**	**6.26**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.71	6.71	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.71	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.71	6.71	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.71	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.50	6.50	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	6.59	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.50	6.50	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	6.58	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.73	6.73	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	7.53	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.26	6.26	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	1.3	1.0	0.41	0.47	6.73	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.39	6.78	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	6.93	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.26	6.26	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	1.3	1.0	0.10	0.13	6.39	9.25	HGL ok
P-115	B5 West	MH-116	1.20	10.37	10.37	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	10.45	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.07	10.07	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	0.5	0.12	0.30	10.37	11.99	HGL ok
P-117	DI-117	DI-118	1.20	9.68	9.68	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	10.07	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.28	9.28	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	9.68	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.35	8.35	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	9.28	11.30	HGL ok
P-114	DI-114	MH-170	1.20	7.07	7.07	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	8.35	10.75	HGL ok
P-110	B4 South	MH-111	1.20	9.63	9.63	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.66	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.49	9.49	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	0.5	0.06	0.14	9.63	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.28	9.28	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	1.3	1.0	0.09	0.21	9.49	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.88	7.88	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.89	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.81	7.81	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.07	7.88	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.68	7.68	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	1.3	1.0	0.05	0.14	7.81	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.52	7.52	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	0.5	0.11	0.16	7.68	8.91	HGL ok
P-124	DI-124	MH-135	1.60	7.32	7.32	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	7.52	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.52	7.52	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.52	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.68	7.68	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	7.75	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.74	7.74	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.74	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.68	7.68	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	7.74	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.55	7.55	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.13	7.68	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.45	7.45	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	0.5	0.06	0.09	7.55	8.91	HGL ok
P-134	DI-134	MH-135	1.60	7.32	7.32	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	7.45	9.44	HGL ok
P-135	MH-135	MH-170	2.00	7.07	7.07	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	0.5	0.10	0.24	7.32	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.55	7.55	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	7.59	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Q*V for determining controling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.29	8.29	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.30	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.15	8.15	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	8.29	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.86	7.86	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	8.15	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.49	7.49	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	7.86	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.29	8.29	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	8.33	10.00	HGL ok
P-167	DI-167	DI-159	1.00	9.18	9.18	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.18	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.12	9.12	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	9.18	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.09	9.09	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	9.12	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.79	8.79	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	9.09	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.09	9.09	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	9.15	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	9.30	9.30	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.35	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	8.90	8.90	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	8.97	10.00	HGL ok
P-163	MH-163	MH-140	1.20	8.41	8.41	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	8.90	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 200 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.82	12.82	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.83	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.80	12.80	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.82	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.60	12.60	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	*0.5*	0.07	0.20	12.80	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.29	12.29	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	12.60	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.91	11.91	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	12.29	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.59	11.59	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	*0.5*	0.16	0.32	11.91	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.27	11.27	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	11.59	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.99	10.99	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	11.27	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.57	10.57	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	*0.5*	0.11	0.41	10.99	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.21	10.21	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	*0.5*	0.27	0.36	10.57	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.00	10.00	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	*0.5*	0.12	0.21	10.21	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.76	9.76	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	*0.5*	0.14	0.24	10.00	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	***0.5***	**0.16**	**0.32**	**9.76**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.21	10.21	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.21	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.21	10.21	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.21	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.00	10.00	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.09	10.09	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.00	10.00	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	10.08	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.23	10.23	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	11.03	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.76	9.76	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	*1.3*	1.0	0.41	0.47	10.23	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.89	9.89	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	10.03	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.76	9.76	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	*1.3*	1.0	0.10	0.13	9.89	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.87	13.87	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.02	0.07	13.95	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.57	13.57	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	*0.5*	0.12	0.30	13.87	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.18	13.18	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	13.57	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.78	12.78	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	13.18	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.85	11.85	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	12.78	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.57	10.57	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	11.85	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.13	13.13	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	13.16	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.99	12.99	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	*0.5*	0.06	0.14	13.13	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.78	12.78	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	*1.3*	1.0	0.09	0.21	12.99	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.38	11.38	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.39	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.31	11.31	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.07	11.38	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.18	11.18	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	*1.3*	1.0	0.05	0.14	11.31	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.02	11.02	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	*0.5*	0.11	0.16	11.18	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.82	10.82	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	11.02	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.02	11.02	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.02	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.18	11.18	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.02	0.07	11.25	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.24	11.24	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.24	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.18	11.18	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	11.24	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.05	11.05	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.13	11.18	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.95	10.95	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	*0.5*	0.06	0.09	11.05	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.82	10.82	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	10.95	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.57	10.57	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	*0.5*	0.10	0.24	10.82	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.05	11.05	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	11.09	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.79	11.79	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.80	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.65	11.65	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	11.79	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.36	11.36	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	11.65	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.99	10.99	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	11.36	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.79	11.79	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.83	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.68	12.68	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.68	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.62	12.62	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.68	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.59	12.59	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.62	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.29	12.29	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	12.59	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.59	12.59	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	12.65	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.80	12.80	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.85	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.40	12.40	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	12.47	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.91	11.91	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	12.40	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add $Hc = 0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.82	12.82	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.83	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.80	12.80	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.82	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.60	12.60	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	*0.5*	0.07	0.20	12.80	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.29	12.29	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	12.60	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.91	11.91	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	12.29	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.59	11.59	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	*0.5*	0.16	0.32	11.91	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.27	11.27	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	11.59	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.99	10.99	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	11.27	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.57	10.57	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	*0.5*	0.11	0.41	10.99	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.21	10.21	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	*0.5*	0.27	0.36	10.57	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.00	10.00	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	*0.5*	0.12	0.21	10.21	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.76	9.76	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	*0.5*	0.14	0.24	10.00	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	***0.5***	**0.16**	**0.32**	**9.76**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.21	10.21	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.21	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.21	10.21	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.21	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.00	10.00	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.09	10.09	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.00	10.00	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	10.08	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.23	10.23	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	11.03	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.76	9.76	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	*1.3*	1.0	0.41	0.47	10.23	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.89	9.89	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	10.03	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.76	9.76	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	*1.3*	1.0	0.10	0.13	9.89	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.87	13.87	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.02	0.07	13.95	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.57	13.57	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	*0.5*	0.12	0.30	13.87	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.18	13.18	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	13.57	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.78	12.78	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	13.18	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.85	11.85	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	12.78	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.57	10.57	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	11.85	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.13	13.13	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	13.16	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.99	12.99	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	*0.5*	0.06	0.14	13.13	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.78	12.78	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	*1.3*	1.0	0.09	0.21	12.99	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.38	11.38	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.39	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.31	11.31	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.07	11.38	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.18	11.18	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	*1.3*	1.0	0.05	0.14	11.31	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.02	11.02	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	*0.5*	0.11	0.16	11.18	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.82	10.82	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	11.02	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.02	11.02	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.02	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.18	11.18	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.02	0.07	11.25	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.24	11.24	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.24	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.18	11.18	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	11.24	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.05	11.05	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.13	11.18	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.95	10.95	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	*0.5*	0.06	0.09	11.05	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.82	10.82	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	10.95	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.57	10.57	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	*0.5*	0.10	0.24	10.82	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.05	11.05	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	11.09	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.79	11.79	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.80	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.65	11.65	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	11.79	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.36	11.36	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	11.65	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.99	10.99	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	11.36	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.79	11.79	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.83	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.68	12.68	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.68	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.62	12.62	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.68	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.59	12.59	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.62	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.29	12.29	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	12.59	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.59	12.59	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	12.65	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.80	12.80	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.85	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.40	12.40	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	12.47	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.91	11.91	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	12.40	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle Δ_o	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_t + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	13.72	13.72	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.73	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.70	13.70	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.72	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.50	13.50	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	0.5	0.07	0.20	13.70	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.19	13.19	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	13.50	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.81	12.81	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	13.19	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.49	12.49	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	0.5	0.16	0.32	12.81	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.17	12.17	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	12.49	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.89	11.89	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	12.17	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.47	11.47	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	0.5	0.11	0.41	11.89	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.11	11.11	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	0.5	0.27	0.36	11.47	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.90	10.90	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	0.5	0.12	0.21	11.11	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.66	10.66	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	0.5	0.14	0.24	10.90	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	**0.5**	**0.16**	**0.32**	**10.66**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.11	11.11	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.11	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.11	11.11	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.11	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.90	10.90	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	10.99	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.90	10.90	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	10.98	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.13	11.13	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	11.93	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.66	10.66	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	1.3	1.0	0.41	0.47	11.13	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.79	10.79	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	10.93	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.66	10.66	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	1.3	1.0	0.10	0.13	10.79	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.77	14.77	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	14.85	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.47	14.47	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	0.5	0.12	0.30	14.77	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.08	14.08	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	14.47	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.68	13.68	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	14.08	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.75	12.75	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	13.68	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.47	11.47	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	12.75	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.03	14.03	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.06	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.89	13.89	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	0.5	0.06	0.14	14.03	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.68	13.68	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	1.3	1.0	0.09	0.21	13.89	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.28	12.28	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.29	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.21	12.21	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.07	12.28	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.08	12.08	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	1.3	1.0	0.05	0.14	12.21	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.92	11.92	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	0.5	0.11	0.16	12.08	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.72	11.72	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	11.92	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.92	11.92	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.92	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.08	12.08	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	12.15	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.14	12.14	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.14	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.08	12.08	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	12.14	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.95	11.95	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.13	12.08	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.85	11.85	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	0.5	0.06	0.09	11.95	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.72	11.72	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	11.85	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.47	11.47	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	0.5	0.10	0.24	11.72	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.95	11.95	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.99	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.69	12.69	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.70	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.55	12.55	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	12.69	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.26	12.26	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	12.55	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.89	11.89	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	12.26	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.69	12.69	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.73	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.58	13.58	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.58	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.52	13.52	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.58	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.49	13.49	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.52	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.19	13.19	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	13.49	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.49	13.49	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	13.55	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.70	13.70	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	13.75	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.30	13.30	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	13.37	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.81	12.81	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	13.30	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 200 -year (50-year for sumps)

Location No.	Location From	Location To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	14.22	14.22	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.23	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	14.20	14.20	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.22	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	14.00	14.00	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	0.5	0.07	0.20	14.20	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.69	13.69	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	14.00	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	13.31	13.31	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	13.69	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.99	12.99	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	0.5	0.16	0.32	13.31	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.67	12.67	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	12.99	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.39	12.39	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	12.67	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.97	11.97	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	0.5	0.11	0.41	12.39	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.61	11.61	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	0.5	0.27	0.36	11.97	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.40	11.40	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	0.5	0.12	0.21	11.61	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.16	11.16	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	0.5	0.14	0.24	11.40	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	**0.5**	**0.16**	**0.32**	**11.16**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.61	11.61	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.61	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.61	11.61	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.61	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.40	11.40	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	11.49	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.40	11.40	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	11.48	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.63	11.63	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	12.43	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.16	11.16	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	1.3	1.0	0.41	0.47	11.63	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.29	11.29	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	11.43	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.16	11.16	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	1.3	1.0	0.10	0.13	11.29	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	15.27	15.27	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	15.35	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.97	14.97	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	0.5	0.12	0.30	15.27	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.58	14.58	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	14.97	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	14.18	14.18	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	14.58	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.25	13.25	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	14.18	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.97	11.97	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	13.25	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.53	14.53	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.56	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.39	14.39	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	0.5	0.06	0.14	14.53	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	14.18	14.18	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	1.3	1.0	0.09	0.21	14.39	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.78	12.78	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.79	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.71	12.71	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.07	12.78	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.58	12.58	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	1.3	1.0	0.05	0.14	12.71	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.42	12.42	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	0.5	0.11	0.16	12.58	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.22	12.22	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	12.42	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.42	12.42	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.42	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.58	12.58	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	12.65	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.64	12.64	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.64	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.58	12.58	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	12.64	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.45	12.45	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.13	12.58	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.35	12.35	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	0.5	0.06	0.09	12.45	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.22	12.22	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	12.35	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.97	11.97	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	0.5	0.10	0.24	12.22	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.45	12.45	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.49	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	13.19	13.19	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.20	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.05	13.05	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	13.19	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.76	12.76	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	13.05	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.39	12.39	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	12.76	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	13.19	13.19	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	13.23	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	14.08	14.08	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.08	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	14.02	14.02	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	14.08	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.99	13.99	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.02	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.69	13.69	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	13.99	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.99	13.99	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	14.05	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	14.20	14.20	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	14.25	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.80	13.80	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	13.87	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.31	13.31	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	13.80	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D (ft)	Tailwater, link to Inlet WSE of downstream pipe TW (ft)	Outlet W. S. Elevation HGL Dn (ft)	Outflow Pipe Diameter D_o (in)	Outflow Pipe Design Flow Q_o (cfs)	Pressure-flow Vel., $V_o=Q_o/A$ V_o (fps)	Skew angle vs. Δ_o (deg)	Outflow Pipe Length L (ft)	Friction Slope S_{fo} (ft/ft)	Friction Loss H_f (ft)	Angle of Curvat O (deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c (ft)	Contraction Loss H_o (ft)	Q*V for determining controlling inflow pipe Q1V1 (ft^4/s^2)	Q*V for determining controlling inflow pipe Q2V2 (ft^4/s^2)	Q*V for determining controlling inflow pipe Q3V3 (ft^4/s^2)	Controlling Inflow Velocity Vi	Expansion Loss Hi (ft)	Controlling In-flow skew Δ_i (deg)	Bend Loss H_Δ (ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t (cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss $H_{t\,adj}$ (ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ H (ft)	Inlet W. S. Elevation HGL Up (ft)	Top of Grate T/G (ft)	HGL Check
P-158	DI-158	DI-154	1.00	14.92	14.92	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.93	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	14.90	14.90	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.92	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	14.70	14.70	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	0.5	0.07	0.20	14.90	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	14.39	14.39	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	14.70	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	14.01	14.01	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	14.39	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	13.69	13.69	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	0.5	0.16	0.32	14.01	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	13.37	13.37	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	13.69	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	13.09	13.09	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	13.37	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.67	12.67	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	0.5	0.11	0.41	13.09	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.31	12.31	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	0.5	0.27	0.36	12.67	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	12.10	12.10	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	0.5	0.12	0.21	12.31	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.86	11.86	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	0.5	0.14	0.24	12.10	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	**0.5**	**0.16**	**0.32**	**11.86**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.31	12.31	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.31	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.31	12.31	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.31	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	12.10	12.10	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	12.19	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	12.10	12.10	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	12.18	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.33	12.33	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	13.13	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.86	11.86	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	1.3	1.0	0.41	0.47	12.33	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.99	11.99	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	12.13	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.86	11.86	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	1.3	1.0	0.10	0.13	11.99	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	15.97	15.97	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	16.05	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	15.67	15.67	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	0.5	0.12	0.30	15.97	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	15.28	15.28	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	15.67	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	14.88	14.88	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	15.28	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.95	13.95	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	14.88	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.67	12.67	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	13.95	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	15.23	15.23	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	15.26	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	15.09	15.09	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	0.5	0.06	0.14	15.23	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	14.88	14.88	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	1.3	1.0	0.09	0.21	15.09	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	13.48	13.48	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.49	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	13.41	13.41	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.07	13.48	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	13.28	13.28	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	1.3	1.0	0.05	0.14	13.41	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	13.12	13.12	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	0.5	0.11	0.16	13.28	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.92	12.92	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	13.12	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	13.12	13.12	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.12	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	13.28	13.28	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	13.35	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	13.34	13.34	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.34	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	13.28	13.28	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	13.34	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	13.15	13.15	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.13	13.28	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	13.05	13.05	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	0.5	0.06	0.09	13.15	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.92	12.92	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	13.05	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.67	12.67	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	0.5	0.10	0.24	12.92	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	13.15	13.15	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	13.19	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	13.89	13.89	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.90	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.75	13.75	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	13.89	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	13.46	13.46	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	13.75	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	13.09	13.09	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	13.46	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	13.89	13.89	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	13.93	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	14.78	14.78	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.78	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	14.72	14.72	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	14.78	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	14.69	14.69	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.72	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	14.39	14.39	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	14.69	10.06	HGL Too High!
P-153	B1	MH-151	1.60	14.69	14.69	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	14.75	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	14.90	14.90	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	14.95	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	14.50	14.50	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	14.57	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	14.01	14.01	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	14.50	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by: TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.: 200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	15.42	15.42	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.43	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	15.40	15.40	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.42	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	15.20	15.20	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	*0.5*	0.07	0.20	15.40	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	14.89	14.89	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	15.20	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	14.51	14.51	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	14.89	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	14.19	14.19	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	*0.5*	0.16	0.32	14.51	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	13.87	13.87	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	14.19	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	13.59	13.59	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	13.87	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	13.17	13.17	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	*0.5*	0.11	0.41	13.59	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.81	12.81	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	*0.5*	0.27	0.36	13.17	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	12.60	12.60	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	*0.5*	0.12	0.21	12.81	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	12.36	12.36	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	*0.5*	0.14	0.24	12.60	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	***0.5***	**0.16**	**0.32**	**12.36**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.81	12.81	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.81	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.81	12.81	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.81	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	12.60	12.60	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.09	12.69	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	12.60	12.60	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.08	12.68	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.83	12.83	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	13.63	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	12.36	12.36	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	*1.3*	1.0	0.41	0.47	12.83	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	12.49	12.49	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	12.63	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	12.36	12.36	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	*1.3*	1.0	0.10	0.13	12.49	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	16.47	16.47	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.02	0.07	16.55	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	16.17	16.17	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	*0.5*	0.12	0.30	16.47	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	15.78	15.78	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	16.17	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	15.38	15.38	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	15.78	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	14.45	14.45	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	15.38	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	13.17	13.17	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	14.45	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	15.73	15.73	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.03	15.76	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	15.59	15.59	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	*0.5*	0.06	0.14	15.73	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	15.38	15.38	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	*1.3*	1.0	0.09	0.21	15.59	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	13.98	13.98	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.99	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	13.91	13.91	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.07	13.98	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	13.78	13.78	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	*1.3*	1.0	0.05	0.14	13.91	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	13.62	13.62	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	*0.5*	0.11	0.16	13.78	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	13.42	13.42	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	13.62	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	13.62	13.62	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.62	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	13.78	13.78	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.02	0.07	13.85	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	13.84	13.84	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.84	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	13.78	13.78	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.06	13.84	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	13.65	13.65	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	*1.3*	1.0	0.04	0.13	13.78	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	13.55	13.55	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	*0.5*	0.06	0.09	13.65	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	13.42	13.42	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	13.55	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	13.17	13.17	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	*0.5*	0.10	0.24	13.42	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	13.65	13.65	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	13.69	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	14.39	14.39	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.40	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	14.25	14.25	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	14.39	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	13.96	13.96	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	14.25	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	13.59	13.59	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	13.96	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	14.39	14.39	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	14.43	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	15.28	15.28	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.28	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	15.22	15.22	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	15.28	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	15.19	15.19	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	15.22	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	14.89	14.89	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	15.19	10.06	HGL Too High!
P-153	B1	MH-151	1.60	15.19	15.19	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	15.25	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	15.40	15.40	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	15.45	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	15.00	15.00	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	15.07	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	14.51	14.51	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	15.00	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle Δ_o	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_i + H_i + H_i$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	16.72	16.72	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.73	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	16.70	16.70	15	1.3	1.1	10	24	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.72	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	16.50	16.50	18	5.7	3.2	89	51	0.0025	0.13	0	0.00	0.04	1.4	11.8	0.0	2.6	0.0	89	0.07	0.15	1.0	0.5	0.07	0.20	16.70	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	16.19	16.19	18	6.2	3.5	94	33	0.0029	0.10	0	0.00	0.05	18.5	0.0	0.0	3.2	0.1	89	0.11	0.22	1.0	1.0	0.22	0.31	16.50	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	15.81	15.81	30	19.7	4.0	85	97	0.0020	0.19	0	0.00	0.06	21.4	58.0	0.0	4.3	0.1	3	0.03	0.19	1.0	1.0	0.19	0.38	16.19	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	15.49	15.49	36	29.1	4.1	2	97	0.0016	0.16	0	0.00	0.07	79.2	58.6	0.0	4.0	0.1	85	0.17	0.32	1.0	0.5	0.16	0.32	15.81	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	15.17	15.17	36	29.4	4.2	1	96	0.0017	0.16	0	0.00	0.07	120.1	0.0	0.0	4.1	0.1	2	0.00	0.16	1.0	1.0	0.16	0.32	15.49	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	14.89	14.89	36	29.8	4.2	5	68	0.0017	0.12	0	0.00	0.07	122.7	0.0	0.0	4.2	0.1	1	0.00	0.16	1.0	1.0	0.16	0.28	15.17	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	14.47	14.47	36	36.8	5.2	86	115	0.0026	0.30	0	0.00	0.11	126.0	24.6	0.0	4.2	0.1	5	0.03	0.23	1.0	0.5	0.11	0.41	14.89	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	14.11	14.11	48	64.5	5.1	0	55	0.0017	0.09	0	0.00	0.10	191.3	91.0	61.5	5.2	0.1	86	0.29	0.54	1.0	0.5	0.27	0.36	14.47	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	13.90	13.90	48	65.7	5.2	0	50	0.0018	0.09	0	0.00	0.11	331.5	0.3	0.4	5.1	0.1	0	0.00	0.25	1.0	0.5	0.12	0.21	14.11	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	13.66	13.66	48	72.8	5.8	0	44	0.0022	0.10	0	0.00	0.13	343.5	10.1	9.3	5.2	0.1	0	0.00	0.28	1.0	0.5	0.14	0.24	13.90	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**77.3**	**6.1**	**0**	**64**	**0.0025**	**0.16**	**0**	**0.00**	**0.15**	**421.8**	**7.9**	**4.1**	**5.8**	**0.2**	**0**	**0.00**	**0.33**	**1.0**	**0.5**	**0.16**	**0.32**	**13.66**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	14.11	14.11	18	0.8	0.4	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.11	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	14.11	14.11	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.11	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	13.90	13.90	18	4.2	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	13.99	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	13.90	13.90	18	4.1	2.3	90	55	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	13.98	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	14.13	14.13	8	1.6	4.6	56	56	0.0128	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.80	14.93	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	13.66	13.66	15	3.1	2.5	90	30	0.0020	0.06	0	0.00	0.03	7.5	0.0	0.0	4.6	0.1	56	0.18	0.32	1.3	1.0	0.41	0.47	14.13	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	13.79	13.79	8	0.8	2.2	45	45	0.0028	0.13	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.15	13.93	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	13.66	13.66	15	2.2	1.8	90	30	0.0010	0.03	0	0.00	0.01	1.6	0.0	0.0	2.2	0.0	45	0.03	0.07	1.3	1.0	0.10	0.13	13.79	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	17.77	17.77	18	6.2	3.5	86	17	0.0030	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	17.85	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	17.47	17.47	18	6.2	3.5	4	60	0.0030	0.18	0	0.00	0.05	21.9	0.0	0.0	3.5	0.1	86	0.13	0.25	1.0	0.5	0.12	0.30	17.77	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	17.08	17.08	18	6.7	3.8	89	71	0.0035	0.25	0	0.00	0.06	21.7	0.0	0.0	3.5	0.1	4	0.02	0.14	1.0	1.0	0.14	0.39	17.47	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	16.68	16.68	18	7.2	4.1	72	27	0.0040	0.11	0	0.00	0.06	25.4	0.0	0.0	3.8	0.1	89	0.16	0.30	1.0	1.0	0.30	0.41	17.08	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	15.75	15.75	18	12.4	7.0	25	41	0.0119	0.49	0	0.00	0.19	29.3	12.7	0.0	4.1	0.1	72	0.16	0.44	1.0	1.0	0.44	0.92	16.68	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	14.47	14.47	18	12.7	7.2	97	47	0.0124	0.58	0	0.00	0.20	86.9	0.0	0.0	7.0	0.3	25	0.23	0.70	1.0	1.0	0.70	1.28	15.75	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	17.03	17.03	18	4.2	2.4	86	17	0.0014	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	17.06	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	16.89	16.89	18	4.2	2.4	4	60	0.0014	0.08	0	0.00	0.02	10.1	0.0	0.0	2.4	0.0	86	0.06	0.11	1.0	0.5	0.06	0.14	17.03	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	16.68	16.68	18	4.7	2.7	19	71	0.0017	0.12	0	0.00	0.03	10.0	0.0	0.0	2.4	0.0	4	0.01	0.07	1.3	1.0	0.09	0.21	16.89	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	15.28	15.28	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.29	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	15.21	15.21	15	1.8	1.5	7	84	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.07	15.28	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	15.08	15.08	15	2.8	2.3	14	56	0.0016	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	7	0.00	0.04	1.3	1.0	0.05	0.14	15.21	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	14.92	14.92	24	8.7	2.8	81	36	0.0013	0.05	0	0.00	0.03	6.4	21.6	0.0	3.5	0.1	81	0.13	0.22	1.0	0.5	0.11	0.16	15.08	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	14.72	14.72	24	9.6	3.1	90	31	0.0015	0.05	0	0.00	0.04	24.1	0.1	0.0	2.8	0.0	81	0.08	0.16	1.0	1.0	0.16	0.20	14.92	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	14.92	14.92	15	0.3	0.2	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.92	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	15.08	15.08	18	6.2	3.5	81	17	0.0029	0.05	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.02	0.07	15.15	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	15.14	15.14	15	0.5	0.4	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.14	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	15.08	15.08	15	1.7	1.4	5	83	0.0006	0.05	0	0.00	0.01	0.2	0.0	0.0	0.4	0.0	6	0.00	0.01	1.3	1.0	0.01	0.06	15.14	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	14.95	14.95	15	2.7	2.2	14	56	0.0015	0.09	0	0.00	0.02	2.5	0.0	0.0	1.4	0.0	5	0.00	0.03	1.3	1.0	0.04	0.13	15.08	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	14.85	14.85	24	7.1	2.3	81	36	0.0008	0.03	0	0.00	0.02	6.1	11.8	0.0	2.6	0.0	81	0.07	0.12	1.0	0.5	0.06	0.09	14.95	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	14.72	14.72	24	7.8	2.5	90	31	0.0010	0.03	0	0.00	0.02	16.0	0.0	0.0	2.3	0.0	81	0.05	0.10	1.0	1.0	0.10	0.14	14.85	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	14.47	14.47	30	17.4	3.5	0	94	0.0015	0.14	0	0.00	0.05	19.6	29.4	0.0	3.1	0.1	90	0.10	0.20	1.0	0.5	0.10	0.24	14.72	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	14.95	14.95	18	4.6	2.6	81	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	14.99	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	15.69	15.69	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.70	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	15.55	15.55	18	5.0	2.8	7	39	0.0019	0.07	0	0.00	0.03	0.2	11.8	0.0	2.6	0.0	83	0.07	0.14	1.0	0.5	0.07	0.14	15.69	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	15.26	15.26	18	5.7	3.2	89	68	0.0025	0.17	0	0.00	0.04	14.0	0.0	0.0	2.8	0.0	7	0.01	0.10	1.3	1.0	0.12	0.29	15.55	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	14.89	14.89	18	6.6	3.7	86	25	0.0034	0.08	0	0.00	0.05	18.1	0.0	0.0	3.2	0.1	89	0.11	0.22	1.3	1.0	0.29	0.37	15.26	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	15.69	15.69	18	4.6	2.6	83	17	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	15.73	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	16.58	16.58	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.58	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	16.52	16.52	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	16.58	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	16.49	16.49	15	2.1	1.7	10	24	0.0009	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	16.52	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	16.19	16.19	24	13.5	4.3	3	51	0.0030	0.15	0	0.00	0.07	3.6	41.8	0.0	3.6	0.1	89	0.14	0.29	1.0	0.5	0.14	0.30	16.49	10.06	HGL Too High!
P-153	B1	MH-151	1.60	16.49	16.49	24	11.5	3.6	89	17	0.0022	0.04	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.06	16.55	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	16.70	16.70	18	4.6	2.6	89	18	0.0016	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	16.75	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	16.30	16.30	18	4.0	2.3	90	50	0.0012	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.07	16.37	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	15.81	15.81	18	10.2	5.8	92	44	0.0080	0.35	0	0.00	0.13	9.2	0.0	9.2	2.3	0.0	90	0.06	0.21	1.3	0.5	0.14	0.49	16.30	10.50	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by: SNR	Date: 2/23/2023	Sheet No.: 3	of 5		
County:	New Castle	Checked by: TMC	Date: 3/23/2023	Cm. No.: 20077.000			
Segment:	East Bank Blvd Outfall	Storm Frequency: 500	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-158	DI-158	DI-154	3887	225	4112	0.09	0.91	0.09	0.09	6.0	0.00	4.01	**0.34**	15	100	0.012	0.000024	0.0053	4.2	**5.1**	2.0	0.82	6.82	**4.36**	3.83	Q ok
P-154	DI-154	MH-155	3023	31	3054	0.07	1.00	0.07	0.16	6.0	6.82	8.21	**1.28**	15	24	0.012	0.000334	0.0042	3.7	**4.5**	3.1	0.13	6.95	**3.73**	3.63	Q ok
P-155	MH-155	DI-156	1	0	1	0.00	1.00	0.00	0.72	6.0	6.95	8.17	**5.88**	18	51	0.012	0.002673	0.0039	4.0	**7.1**	4.6	0.19	7.13	3.53	3.33	Q ok
P-156	DI-156	DI-152	2725	0	2725	0.06	1.00	0.06	0.78	6.0	7.13	8.10	**6.34**	18	33	0.012	0.003101	0.0039	4.0	**7.1**	4.6	0.12	7.25	3.23	3.10	Q ok
P-152	DI-152	MH-140	3517	0	3517	0.08	1.00	0.08	2.52	6.0	7.25	8.02	**20.23**	**30**	97	0.012	0.002073	0.0040	5.7	**28.2**	6.3	0.26	7.51	3.00	2.61	Q ok
P-140	MH-140	DI-141	1	0	1	0.00	1.00	0.00	3.79	6.0	7.51	7.95	**30.13**	36	97	0.012	0.001739	0.0040	6.5	**45.8**	6.9	0.23	7.74	2.51	2.12	Q ok
P-141	DI-141	DI-142	3263	65	3328	0.08	1.00	0.08	3.87	6.0	7.74	7.88	**30.45**	36	96	0.012	0.001776	0.0040	6.4	**45.5**	6.9	0.23	7.98	2.02	1.64	Q ok
P-142	DI-142	DI-143	3699	195	3894	0.09	1.00	0.09	3.96	6.0	7.98	7.76	**30.71**	36	68	0.012	0.001807	0.0040	6.4	**45.5**	6.9	0.16	8.14	1.54	1.27	Q ok
P-143	DI-143	MH-170	5428	266	5694	0.13	1.00	0.13	4.93	6.0	8.14	7.73	**38.06**	36	115	0.012	0.002775	0.0040	6.5	**45.7**	7.3	0.26	8.40	1.17	0.71	Q ok
P-170	MH-170	MH-171	1	0	1	0.00	1.00	0.00	8.79	6.0	8.40	7.62	**66.95**	48	55	0.012	0.001851	0.0040	7.8	**98.4**	8.5	0.11	8.51	0.61	0.39	Q ok
P-171	MH-171	MH-172	1	0	1	0.00	1.00	0.00	8.99	6.0	8.51	7.58	**68.14**	48	50	0.012	0.001917	0.0040	7.8	**98.4**	8.5	0.10	8.61	0.29	0.09	Q ok
P-172	MH-172	MH-173	1	0	1	0.00	1.00	0.00	10.02	6.0	8.61	7.54	**75.53**	48	44	0.012	0.002356	0.0041	7.9	**99.5**	8.8	0.08	8.69	-0.01	-0.19	Q ok
P-173	MH-173	OUTFALL	1	0	1	0.00	1.00	0.00	10.68	6.0	8.69	7.50	**80.15**	**48**	64	0.012	0.002653	0.0041	7.9	**99.2**	8.8	0.12	8.81	-0.29	**-0.55**	Q ok
P-174	DI-174	MH-171	3578	530	4108	0.09	1.00	0.09	0.09	6.0	0.00	8.51	**0.80**	18	33	0.012	0.000050	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-175	DI-175	MH-171	4118	530	4648	0.11	1.00	0.11	0.11	6.0	0.00	8.51	**0.91**	18	33	0.012	0.000064	0.0200	9.1	**16.1**	4.5	0.12	6.12	1.95	1.29	Q ok
P-176	B4 North	MH-172	22780	0	22780	0.52	1.00	0.52	0.52	6.0	0.00	8.51	**4.45**	18	55	0.012	0.001529	0.0049	4.5	**8.0**	4.6	0.20	6.20	1.26	0.99	Q ok
P-177	B2 South	MH-172	21809	0	21809	0.50	1.00	0.50	0.50	6.0	0.00	8.51	**4.26**	18	55	0.012	0.001401	0.0049	4.5	**8.0**	4.6	0.20	6.20	1.26	0.99	Q ok
P-178	TD-03	DI-179	8687	0	8687	0.20	1.00	0.20	0.20	6.0	0.00	8.51	**1.70**	8	56	0.011	0.014115	0.0509	9.2	**3.2**	9.4	0.10	6.10	8.55	5.70	Q ok
P-179	DI-179	MH-173	6306	3055	9361	0.21	0.87	0.19	0.39	6.0	6.10	8.47	**3.28**	15	30	0.012	0.002196	0.0500	12.8	**15.6**	9.6	0.05	6.15	3.21	1.71	Q ok
P-180	TD-02	DI-181	4084	0	4084	0.09	1.00	0.09	0.09	6.0	0.00	8.51	**0.80**	8	45	0.011	0.003120	0.0500	9.1	**3.2**	7.5	0.10	6.10	8.50	6.25	Q ok
P-181	DI-181	MH-173	6222	2906	9128	0.21	0.88	0.18	0.28	6.0	6.10	8.47	**2.36**	15	30	0.012	0.001135	0.0500	12.8	**15.6**	8.9	0.06	6.16	3.21	1.71	Q ok
P-115	B5 West	MH-116	33468	0	33468	0.77	1.00	0.77	0.77	6.0	0.00	8.51	**6.54**	18	17	0.012	0.003300	0.0047	4.4	**7.8**	5.0	0.06	6.06	3.84	3.76	Q ok
P-116	MH-116	DI-117	1	0	1	0.00	1.00	0.00	0.77	6.0	6.06	8.47	**6.51**	18	60	0.012	0.003271	0.0050	4.6	**8.0**	5.1	0.20	6.25	3.66	3.36	Q ok
P-117	DI-117	DI-118	2919	167	3086	0.07	1.00	0.07	0.84	6.0	6.25	8.40	**7.05**	18	71	0.012	0.003834	0.0051	4.6	**8.1**	5.2	0.23	6.48	3.26	2.90	Q ok
P-118	DI-118	DI-113	2866	196	3062	0.07	1.00	0.07	0.91	6.0	6.48	8.32	**7.57**	18	27	0.012	0.004424	0.0048	4.5	**7.9**	5.2	0.09	6.57	2.80	2.67	Q ok
P-113	DI-113	DI-114	2882	195	3077	0.07	1.00	0.07	1.57	6.0	6.57	8.28	**13.03**	18	41	0.012	0.013102	0.0200	9.1	**16.1**	10.2	0.07	6.64	2.57	1.75	Q ok
P-114	DI-114	MH-170	1592	20	1612	0.04	1.00	0.04	1.61	6.0	6.64	8.28	**13.33**	18	47	0.012	0.013726	0.0200	9.1	**16.1**	10.3	0.08	6.71	1.65	0.71	Q ok
P-110	B4 South	MH-111	22751	0	22751	0.52	1.00	0.52	0.52	6.0	0.00	8.51	**4.44**	18	17	0.012	0.001525	0.0053	4.7	**8.3**	4.8	0.06	6.06	3.61	3.52	Q ok
P-111	MH-111	DI-112	1	0	1	0.00	1.00	0.00	0.52	6.0	6.06	8.47	**4.42**	18	60	0.012	0.001512	0.0050	4.6	**8.0**	4.6	0.22	6.27	3.42	3.12	Q ok
P-112	DI-112	DI-113	2877	164	3041	0.07	1.00	0.07	0.59	6.0	6.27	8.40	**4.97**	18	71	0.012	0.001909	0.0049	4.5	**8.0**	4.7	0.25	6.52	3.02	2.67	Q ok
P-120	DI-120	DI-121	2879	334	3213	0.07	1.00	0.07	0.07	6.0	0.00	8.51	**0.63**	15	22	0.012	0.000080	0.0032	3.2	**3.9**	2.3	0.16	6.16	**3.96**	3.89	Q ok
P-121	DI-121	DI-122	5403	1316	6719	0.15	1.00	0.15	0.23	6.0	6.16	8.43	**1.92**	15	84	0.012	0.000754	0.0031	3.2	**3.9**	3.1	0.45	6.61	3.79	3.53	Q ok
P-122	DI-122	MH-123	4404	1304	5708	0.13	0.97	0.13	0.35	6.0	6.61	8.28	**2.94**	15	56	0.012	0.001763	0.0030	3.1	**3.9**	3.5	0.27	6.88	3.43	3.26	Q ok
P-123	MH-123	DI-124	1	0	1	0.00	1.00	0.00	1.12	6.0	6.88	8.17	**9.14**	**24**	36	0.012	0.001392	0.0036	4.7	**14.7**	4.9	0.12	7.00	3.16	3.03	Q ok
P-124	DI-124	MH-135	3437	323	3760	0.09	1.00	0.09	1.24	6.0	7.00	8.14	**10.10**	**24**	31	0.012	0.001699	0.0048	5.4	**17.0**	5.7	0.09	7.09	2.93	2.78	Q ok
P-125	DI-125	DI-124	1587	15	1602	0.04	1.00	0.04	0.04	6.0	0.00	8.51	**0.31**	15	45	0.012	0.000020	0.0040	3.6	**4.4**	1.8	0.42	6.42	3.21	3.03	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 3 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: East Bank Blvd Outfall | Storm Frequency: 500 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P-126	B5 North	MH-123	33276	0	33276	0.76	1.00	0.76	0.76	6.0	0.00	8.51	**6.50**	18	17	0.012	0.003262	0.0053	4.7	**8.3**	5.2	0.05	6.05	3.36	3.27	Q ok
P-130	DI-130	DI-131	2606	339	2945	0.07	1.00	0.07	0.07	6.0	0.00	8.51	**0.58**	15	22	0.012	0.000068	0.0032	3.2	**3.9**	2.3	0.16	6.16	**3.96**	3.89	Q ok
P-131	DI-131	DI-132	5203	1533	6736	0.15	0.97	0.15	0.22	6.0	6.16	8.43	**1.83**	15	83	0.012	0.000686	0.0030	3.1	**3.8**	3.1	0.45	6.61	3.79	3.54	Q ok
P-132	DI-132	MH-133	4517	1246	5763	0.13	0.98	0.13	0.35	6.0	6.61	8.28	**2.87**	15	56	0.012	0.001687	0.0030	3.1	**3.9**	3.5	0.27	6.88	3.44	3.27	Q ok
P-133	MH-133	DI-134	1	0	1	0.00	1.00	0.00	0.91	6.0	6.88	8.17	**7.45**	24	36	0.012	0.000923	0.0031	4.3	**13.5**	4.4	0.14	7.01	3.17	3.06	Q ok
P-134	DI-134	MH-135	4193	284	4477	0.10	1.00	0.10	1.01	6.0	7.01	8.14	**8.25**	**24**	31	0.012	0.001133	0.0035	4.6	**14.6**	4.7	0.11	7.12	2.96	2.85	Q ok
P-135	MH-135	MH-170	1	0	1	0.00	1.00	0.00	2.26	6.0	7.12	8.10	**18.27**	**30**	94	0.012	0.001690	0.0039	5.7	**27.9**	6.1	0.26	7.38	2.67	2.30	Q ok
P-136	B3 South	MH-133	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	8.51	**4.80**	18	17	0.012	0.001778	0.0047	4.4	**7.8**	4.6	0.06	6.06	3.36	3.28	Q ok
P-144	DI-144	MH-145	2618	65	2683	0.06	1.00	0.06	0.06	6.0	0.00	8.51	**0.52**	15	55	0.012	0.000056	0.0051	4.1	**5.0**	2.4	0.38	6.38	3.79	3.51	Q ok
P-145	MH-145	DI-146	1	0	1	0.00	1.00	0.00	0.63	6.0	6.38	8.36	**5.23**	18	39	0.012	0.002112	0.0049	4.5	**7.9**	4.8	0.14	6.51	3.41	3.22	Q ok
P-146	DI-146	DI-147	3675	195	3870	0.09	1.00	0.09	0.71	6.0	6.51	8.32	**5.95**	18	68	0.012	0.002730	0.0050	4.6	**8.0**	5.1	0.22	6.73	3.12	2.78	Q ok
P-147	DI-147	DI-143	5191	266	5457	0.13	1.00	0.13	0.84	6.0	6.73	8.25	**6.93**	18	25	0.012	0.003704	0.0052	4.6	**8.2**	5.2	0.08	6.81	2.68	2.55	Q ok
P-148	B3 West	MH-145	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	8.51	**4.80**	18	17	0.012	0.001778	0.0053	4.7	**8.3**	4.9	0.06	6.06	3.60	3.51	Q ok
P-167	DI-167	DI-159	3909	227	4136	0.09	0.91	0.09	0.09	6.0	6.00	4.01	**0.35**	15	18	0.012	0.000024	0.0033	3.3	**4.0**	2.0	0.15	6.15	4.29	4.23	Q ok
P-159	DI-159	DI-150	3909	227	4136	0.09	0.91	0.09	0.17	6.0	6.15	3.98	**0.69**	15	100	0.012	0.000096	0.0053	4.2	**5.1**	2.9	0.57	6.73	4.13	3.60	Q ok
P-150	DI-150	MH-151	3037	0	3037	0.07	1.00	0.07	0.24	6.0	0.00	8.51	**2.06**	15	24	0.012	0.000866	0.0042	3.7	**4.5**	3.6	0.11	6.11	3.50	3.40	Q ok
P-151	MH-151	DI-152	1	0	1	0.00	1.00	0.00	1.66	6.0	6.11	8.47	**14.04**	24	51	0.012	0.003283	0.0039	4.9	**15.3**	5.6	0.15	6.26	3.30	3.10	Q ok
P-153	B1	MH-151	61668	0	61668	1.42	1.00	1.42	1.42	6.0	0.00	8.51	**12.04**	24	17	0.012	0.002415	0.0100	7.8	**24.5**	7.7	0.04	6.04	3.57	3.40	Q ok
P-157	B3 North	MH-155	24569	0	24569	0.56	1.00	0.56	0.56	6.0	0.00	8.51	**4.80**	18	18	0.012	0.001778	0.0050	4.6	**8.0**	4.8	0.06	6.06	3.72	3.63	Q ok
P-166	B2 North	MH-163	21657	0	21657	0.50	1.00	0.50	0.50	6.0	0.00	8.51	**4.23**	18	50	0.012	0.001382	0.0050	4.6	**8.0**	4.6	0.18	6.18	3.62	3.37	Q ok
P-163	MH-163	MH-140	1	0	1	0.00	1.00	0.00	1.27	6.0	6.18	8.43	**10.70**	18	44	0.012	0.008844	0.0150	7.9	**13.9**	8.8	0.08	6.26	3.27	2.61	Q ok

KEY	
	Upsized from Semi-Final Design to have capacity for 50-yr design storm
	Optional Upsize-50-yr design storm results in >85% Full
	No Change from Semi-Final Design

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)		

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	6.93	6.93	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.95	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	6.92	6.92	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.93	9.06	HGL ok
P-155	MH-155	DI-156	1.20	6.70	6.70	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	6.92	10.06	HGL ok
P-156	DI-156	DI-152	1.20	6.35	6.35	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	6.70	11.07	HGL ok
P-152	DI-152	MH-140	2.00	5.93	5.93	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	6.35	11.07	HGL ok
P-140	MH-140	DI-141	2.40	5.57	5.57	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	5.93	12.04	HGL ok
P-141	DI-141	DI-142	2.40	5.22	5.22	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	5.57	11.02	HGL ok
P-142	DI-142	DI-143	2.40	4.91	4.91	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	5.22	10.52	HGL ok
P-143	DI-143	MH-170	2.40	4.46	4.46	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	4.91	10.28	HGL ok
P-170	MH-170	MH-171	3.20	4.05	4.05	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	4.46	11.16	HGL ok
P-171	MH-171	MH-172	3.20	3.82	3.82	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	4.05	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.56	3.56	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	3.82	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.20**	**3.20**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**3.56**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	4.05	4.05	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.06	10.61	HGL ok
P-175	DI-175	MH-171	1.20	4.05	4.05	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.06	10.63	HGL ok
P-176	B4 North	MH-172	1.20	3.82	3.82	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	3.91	10.00	HGL ok
P-177	B2 South	MH-172	1.20	3.82	3.82	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	3.91	10.00	HGL ok
P-178	TD-03	DI-179	0.53	4.08	6.23	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	7.12	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.56	3.56	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	4.08	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.70	6.78	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	6.94	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.56	3.56	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	3.70	9.25	HGL ok
P-115	B5 West	MH-116	1.20	8.10	8.10	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	8.19	10.00	HGL ok
P-116	MH-116	DI-117	1.20	7.77	7.77	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	8.10	11.99	HGL ok
P-117	DI-117	DI-118	1.20	7.34	7.34	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	7.77	11.71	HGL ok
P-118	DI-118	DI-113	1.20	6.89	6.89	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	7.34	11.30	HGL ok
P-113	DI-113	DI-114	1.20	5.87	5.87	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	6.89	11.30	HGL ok
P-114	DI-114	MH-170	1.20	4.46	4.46	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	5.87	10.75	HGL ok
P-110	B4 South	MH-111	1.20	7.28	7.28	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	7.32	10.00	HGL ok
P-111	MH-111	DI-112	1.20	7.12	7.12	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	7.28	11.99	HGL ok
P-112	DI-112	DI-113	1.20	6.89	6.89	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	7.12	11.71	HGL ok
P-120	DI-120	DI-121	1.00	5.35	5.35	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.35	7.10	HGL ok
P-121	DI-121	DI-122	1.00	5.27	5.27	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	5.35	7.05	HGL ok
P-122	DI-122	MH-123	1.00	5.12	5.12	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	5.27	7.81	HGL ok
P-123	MH-123	DI-124	1.60	4.95	4.95	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	5.12	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.73	4.73	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	4.95	9.44	HGL ok
P-125	DI-125	DI-124	1.00	4.95	4.95	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.95	10.67	HGL ok
P-126	B5 North	MH-123	1.20	5.12	5.12	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	5.21	10.00	HGL ok
P-130	DI-130	DI-131	1.00	5.19	5.19	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.19	7.10	HGL ok
P-131	DI-131	DI-132	1.00	5.12	5.12	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	5.19	7.15	HGL ok
P-132	DI-132	MH-133	1.00	4.98	4.98	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	5.12	7.81	HGL ok
P-133	MH-133	DI-134	1.60	4.88	4.88	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	4.98	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.73	4.73	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	4.88	9.44	HGL ok
P-135	MH-135	MH-170	2.00	4.46	4.46	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	4.73	10.15	HGL ok
P-136	B3 South	MH-133	1.20	4.98	4.98	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	5.02	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	5.80	5.80	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.81	11.02	HGL ok
P-145	MH-145	DI-146	1.20	5.64	5.64	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	5.80	10.87	HGL ok
P-146	DI-146	DI-147	1.20	5.32	5.32	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	5.64	10.52	HGL ok
P-147	DI-147	DI-143	1.20	4.91	4.91	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	5.32	10.28	HGL ok
P-148	B3 West	MH-145	1.20	5.80	5.80	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	5.85	10.00	HGL ok
P-167	DI-167	DI-159	1.00	6.78	6.78	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.78	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	6.72	6.72	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	6.78	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	6.68	6.68	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	6.72	9.06	HGL ok
P-151	MH-151	DI-152	1.60	6.35	6.35	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	6.68	10.06	HGL ok
P-153	B1	MH-151	1.60	6.68	6.68	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	6.75	10.00	HGL ok
P-157	B3 North	MH-155	1.20	6.92	6.92	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	6.97	10.00	HGL ok
P-166	B2 North	MH-163	1.20	6.47	6.47	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	6.55	10.00	HGL ok
P-163	MH-163	MH-140	1.20	5.93	5.93	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	6.47	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H=H_f+H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	7.13	7.13	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.15	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	7.12	7.12	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.13	9.06	HGL ok
P-155	MH-155	DI-156	1.20	6.90	6.90	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	7.12	10.06	HGL ok
P-156	DI-156	DI-152	1.20	6.55	6.55	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	6.90	11.07	HGL ok
P-152	DI-152	MH-140	2.00	6.13	6.13	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	6.55	11.07	HGL ok
P-140	MH-140	DI-141	2.40	5.77	5.77	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	6.13	12.04	HGL ok
P-141	DI-141	DI-142	2.40	5.42	5.42	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	5.77	11.02	HGL ok
P-142	DI-142	DI-143	2.40	5.11	5.11	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	5.42	10.52	HGL ok
P-143	DI-143	MH-170	2.40	4.66	4.66	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	5.11	10.28	HGL ok
P-170	MH-170	MH-171	3.20	4.25	4.25	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	4.66	11.16	HGL ok
P-171	MH-171	MH-172	3.20	4.02	4.02	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	4.25	10.83	HGL ok
P-172	MH-172	MH-173	3.20	3.76	3.76	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	4.02	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**3.40**	**3.40**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**3.76**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	4.25	4.25	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.26	10.61	HGL ok
P-175	DI-175	MH-171	1.20	4.25	4.25	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.26	10.63	HGL ok
P-176	B4 North	MH-172	1.20	4.02	4.02	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	4.11	10.00	HGL ok
P-177	B2 South	MH-172	1.20	4.02	4.02	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	4.11	10.00	HGL ok
P-178	TD-03	DI-179	0.53	4.28	6.23	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	7.12	10.50	HGL ok
P-179	DI-179	MH-173	1.00	3.76	3.76	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	4.28	9.25	HGL ok
P-180	TD-02	DI-181	0.53	3.90	6.78	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	6.94	10.50	HGL ok
P-181	DI-181	MH-173	1.00	3.76	3.76	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	3.90	9.25	HGL ok
P-115	B5 West	MH-116	1.20	8.30	8.30	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	8.39	10.00	HGL ok
P-116	MH-116	DI-117	1.20	7.97	7.97	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	8.30	11.99	HGL ok
P-117	DI-117	DI-118	1.20	7.54	7.54	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	7.97	11.71	HGL ok
P-118	DI-118	DI-113	1.20	7.09	7.09	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	7.54	11.30	HGL ok
P-113	DI-113	DI-114	1.20	6.07	6.07	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	7.09	11.30	HGL ok
P-114	DI-114	MH-170	1.20	4.66	4.66	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	6.07	10.75	HGL ok
P-110	B4 South	MH-111	1.20	7.48	7.48	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	7.52	10.00	HGL ok
P-111	MH-111	DI-112	1.20	7.32	7.32	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	7.48	11.99	HGL ok
P-112	DI-112	DI-113	1.20	7.09	7.09	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	7.32	11.71	HGL ok
P-120	DI-120	DI-121	1.00	5.55	5.55	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.55	7.10	HGL ok
P-121	DI-121	DI-122	1.00	5.47	5.47	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	5.55	7.05	HGL ok
P-122	DI-122	MH-123	1.00	5.32	5.32	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	5.47	7.81	HGL ok
P-123	MH-123	DI-124	1.60	5.15	5.15	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	5.32	8.91	HGL ok
P-124	DI-124	MH-135	1.60	4.93	4.93	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	5.15	9.44	HGL ok
P-125	DI-125	DI-124	1.00	5.15	5.15	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.15	10.67	HGL ok
P-126	B5 North	MH-123	1.20	5.32	5.32	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	5.41	10.00	HGL ok
P-130	DI-130	DI-131	1.00	5.39	5.39	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.39	7.10	HGL ok
P-131	DI-131	DI-132	1.00	5.32	5.32	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	5.39	7.15	HGL ok
P-132	DI-132	MH-133	1.00	5.18	5.18	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	5.32	7.81	HGL ok
P-133	MH-133	DI-134	1.60	5.08	5.08	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	5.18	8.91	HGL ok
P-134	DI-134	MH-135	1.60	4.93	4.93	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	5.08	9.44	HGL ok
P-135	MH-135	MH-170	2.00	4.66	4.66	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	4.93	10.15	HGL ok
P-136	B3 South	MH-133	1.20	5.18	5.18	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	5.22	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	6.00	6.00	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.01	11.02	HGL ok
P-145	MH-145	DI-146	1.20	5.84	5.84	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	6.00	10.87	HGL ok
P-146	DI-146	DI-147	1.20	5.52	5.52	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	5.84	10.52	HGL ok
P-147	DI-147	DI-143	1.20	5.11	5.11	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	5.52	10.28	HGL ok
P-148	B3 West	MH-145	1.20	6.00	6.00	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	6.05	10.00	HGL ok
P-167	DI-167	DI-159	1.00	6.98	6.98	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.98	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	6.92	6.92	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	6.98	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	6.88	6.88	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	6.92	9.06	HGL ok
P-151	MH-151	DI-152	1.60	6.55	6.55	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	6.88	10.06	HGL ok
P-153	B1	MH-151	1.60	6.88	6.88	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	6.95	10.00	HGL ok
P-157	B3 North	MH-155	1.20	7.12	7.12	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	7.17	10.00	HGL ok
P-166	B2 North	MH-163	1.20	6.67	6.67	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	6.75	10.00	HGL ok
P-163	MH-163	MH-140	1.20	6.13	6.13	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	6.67	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR
Checked by: TMC
Design Freq.: 500 -year (50-year for sumps)

Date: 2/23/23
Date: 3/23/23

Sheet No.: 3 of 5
Cm. No.: 20077

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H=H_f+H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
			0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	10.63	10.63	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.65	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	10.62	10.62	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.63	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.40	10.40	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	10.62	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.05	10.05	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	10.40	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	9.63	9.63	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	10.05	11.07	HGL ok
P-140	MH-140	DI-141	2.40	9.27	9.27	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	9.63	12.04	HGL ok
P-141	DI-141	DI-142	2.40	8.92	8.92	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	9.27	11.02	HGL ok
P-142	DI-142	DI-143	2.40	8.61	8.61	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	8.92	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.16	8.16	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	8.61	10.28	HGL ok
P-170	MH-170	MH-171	3.20	7.75	7.75	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	8.16	11.16	HGL ok
P-171	MH-171	MH-172	3.20	7.52	7.52	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	7.75	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.26	7.26	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	7.52	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**7.26**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	7.75	7.75	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.76	10.61	HGL ok
P-175	DI-175	MH-171	1.20	7.75	7.75	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.76	10.63	HGL ok
P-176	B4 North	MH-172	1.20	7.52	7.52	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	7.61	10.00	HGL ok
P-177	B2 South	MH-172	1.20	7.52	7.52	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	7.61	10.00	HGL ok
P-178	TD-03	DI-179	0.53	7.78	7.78	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	8.66	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.26	7.26	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	7.78	9.25	HGL ok
P-180	TD-02	DI-181	0.53	7.40	7.40	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	7.56	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.26	7.26	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	7.40	9.25	HGL ok
P-115	B5 West	MH-116	1.20	11.80	11.80	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	11.89	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.47	11.47	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	11.80	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.04	11.04	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	11.47	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	10.59	10.59	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	11.04	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	9.57	9.57	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	10.59	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	8.16	8.16	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	9.57	10.75	HGL ok
P-110	B4 South	MH-111	1.20	10.98	10.98	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.02	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	10.82	10.82	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	10.98	11.99	HGL ok
P-112	DI-112	DI-113	1.20	10.59	10.59	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	10.82	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	9.05	9.05	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.05	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.97	8.97	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	9.05	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	8.82	8.82	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	8.97	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	8.65	8.65	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	8.82	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.43	8.43	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	8.65	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	8.65	8.65	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.65	10.67	HGL ok
P-126	B5 North	MH-123	1.20	8.82	8.82	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	8.91	10.00	HGL ok
P-130	DI-130	DI-131	1.00	8.89	8.89	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.89	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	8.82	8.82	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	8.89	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	8.68	8.68	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	8.82	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	8.58	8.58	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	8.68	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.43	8.43	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	8.58	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.16	8.16	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	8.43	10.15	HGL ok
P-136	B3 South	MH-133	1.20	8.68	8.68	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	8.72	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V$_o$^{2}/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H$_f$ +H$_i$ +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H$_f$ + H$_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	9.50	9.50	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.51	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.34	9.34	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	9.50	10.87	HGL ok
P-146	DI-146	DI-147	1.20	9.02	9.02	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	9.34	10.52	HGL ok
P-147	DI-147	DI-143	1.20	8.61	8.61	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	9.02	10.28	HGL ok
P-148	B3 West	MH-145	1.20	9.50	9.50	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.55	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.48	10.48	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.48	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.42	10.42	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.48	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.38	10.38	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	10.42	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.05	10.05	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	10.38	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.38	10.38	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	10.45	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	10.62	10.62	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	10.67	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.17	10.17	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	10.25	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	9.63	9.63	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	10.17	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 500 -year (50-year for sumps)

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	11.13	11.13	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.15	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.12	11.12	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.13	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	10.90	10.90	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	11.12	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.55	10.55	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	10.90	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.13	10.13	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	10.55	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	9.77	9.77	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	10.13	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.42	9.42	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	9.77	11.02	HGL ok
P-142	DI-142	DI-143	2.40	9.11	9.11	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	9.42	10.52	HGL ok
P-143	DI-143	MH-170	2.40	8.66	8.66	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	9.11	10.28	HGL ok
P-170	MH-170	MH-171	3.20	8.25	8.25	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	8.66	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.02	8.02	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	8.25	10.83	HGL ok
P-172	MH-172	MH-173	3.20	7.76	7.76	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	8.02	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**7.76**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.25	8.25	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.26	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.25	8.25	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.26	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.02	8.02	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	8.11	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.02	8.02	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	8.11	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.28	8.28	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	9.16	10.50	HGL ok
P-179	DI-179	MH-173	1.00	7.76	7.76	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	8.28	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	7.90	7.90	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	8.06	10.50	HGL ok
P-181	DI-181	MH-173	1.00	7.76	7.76	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	7.90	9.25	HGL ok
P-115	B5 West	MH-116	1.20	12.30	12.30	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	12.39	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	11.97	11.97	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	12.30	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.54	11.54	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	11.97	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.09	11.09	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	11.54	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.07	10.07	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	11.09	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	8.66	8.66	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	10.07	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.48	11.48	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.52	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.32	11.32	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	11.48	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.09	11.09	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	11.32	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	9.55	9.55	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.55	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.47	9.47	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	9.55	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.32	9.32	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	9.47	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.15	9.15	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	9.32	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	8.93	8.93	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	9.15	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.15	9.15	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.15	10.67	HGL ok
P-126	B5 North	MH-123	1.20	9.32	9.32	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	9.41	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.39	9.39	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.39	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.32	9.32	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	9.39	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.18	9.18	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	9.32	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.08	9.08	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	9.18	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	8.93	8.93	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	9.08	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	8.66	8.66	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	8.93	10.15	HGL ok
P-136	B3 South	MH-133	1.20	9.18	9.18	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.22	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.00	10.00	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.01	11.02	HGL ok
P-145	MH-145	DI-146	1.20	9.84	9.84	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	10.00	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	9.52	9.52	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	9.84	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.11	9.11	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	9.52	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.00	10.00	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.05	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	10.98	10.98	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.98	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	10.92	10.92	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	10.98	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	10.88	10.88	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	10.92	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.55	10.55	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	10.88	10.06	HGL Too High!
P-153	B1	MH-151	1.60	10.88	10.88	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	10.95	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.12	11.12	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	11.17	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	10.67	10.67	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	10.75	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.13	10.13	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	10.67	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	11.53	11.53	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.55	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	11.52	11.52	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.53	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.30	11.30	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	11.52	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	10.95	10.95	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	11.30	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	10.53	10.53	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	10.95	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.17	10.17	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	10.53	12.04	HGL ok
P-141	DI-141	DI-142	2.40	9.82	9.82	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	10.17	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	9.51	9.51	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	9.82	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.06	9.06	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	9.51	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	8.65	8.65	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	9.06	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.42	8.42	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	8.65	10.83	HGL ok
P-172	MH-172	MH-173	3.20	8.16	8.16	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	8.42	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**8.16**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	8.65	8.65	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.66	10.61	HGL ok
P-175	DI-175	MH-171	1.20	8.65	8.65	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.66	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.42	8.42	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	8.51	10.00	HGL ok
P-177	B2 South	MH-172	1.20	8.42	8.42	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	8.51	10.00	HGL ok
P-178	TD-03	DI-179	0.53	8.68	8.68	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	9.56	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	8.16	8.16	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	8.68	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	8.30	8.30	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	8.46	10.50	HGL ok
P-181	DI-181	MH-173	1.00	8.16	8.16	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	8.30	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	12.70	12.70	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	12.79	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.37	12.37	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	12.70	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	11.94	11.94	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	12.37	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.49	11.49	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	11.94	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.47	10.47	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	11.49	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	9.06	9.06	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	10.47	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	11.88	11.88	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	11.92	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	11.72	11.72	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	11.88	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.49	11.49	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	11.72	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	9.95	9.95	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.95	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	9.87	9.87	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	9.95	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	9.72	9.72	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	9.87	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	9.55	9.55	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	9.72	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.33	9.33	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	9.55	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	9.55	9.55	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.55	10.67	HGL ok
P-126	B5 North	MH-123	1.20	9.72	9.72	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	9.81	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	9.79	9.79	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.79	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	9.72	9.72	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	9.79	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	9.58	9.58	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	9.72	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.48	9.48	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	9.58	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.33	9.33	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	9.48	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.06	9.06	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	9.33	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	9.58	9.58	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.62	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.40	10.40	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.41	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.24	10.24	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	10.40	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	9.92	9.92	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	10.24	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	9.51	9.51	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	9.92	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.40	10.40	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.45	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.38	11.38	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.38	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.32	11.32	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.38	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.28	11.28	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	11.32	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	10.95	10.95	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	11.28	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.28	11.28	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	11.35	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	11.52	11.52	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	11.57	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.07	11.07	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	11.15	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	10.53	10.53	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	11.07	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.03	12.03	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.05	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.02	12.02	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.03	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	11.80	11.80	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	12.02	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	11.45	11.45	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	11.80	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.03	11.03	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	11.45	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	10.67	10.67	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	11.03	12.04	HGL ok
P-141	DI-141	DI-142	2.40	10.32	10.32	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	10.67	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.01	10.01	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	10.32	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	9.56	9.56	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	10.01	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.15	9.15	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	9.56	11.16	HGL ok
P-171	MH-171	MH-172	3.20	8.92	8.92	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	9.15	10.83	HGL ok
P-172	MH-172	MH-173	3.20	8.66	8.66	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	8.92	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**8.66**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	9.15	9.15	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.16	10.61	HGL ok
P-175	DI-175	MH-171	1.20	9.15	9.15	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.16	10.63	HGL ok
P-176	B4 North	MH-172	1.20	8.92	8.92	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	9.01	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	8.92	8.92	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	9.01	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.18	9.18	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	10.06	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	8.66	8.66	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	9.18	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	8.80	8.80	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	8.96	10.50	HGL ok
P-181	DI-181	MH-173	1.00	8.66	8.66	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	8.80	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.20	13.20	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	13.29	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	12.87	12.87	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	13.20	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	12.44	12.44	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	12.87	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	11.99	11.99	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	12.44	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	10.97	10.97	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	11.99	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	9.56	9.56	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	10.97	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	12.38	12.38	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	12.42	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.22	12.22	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	12.38	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	11.99	11.99	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	12.22	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	10.45	10.45	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.45	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	10.37	10.37	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	10.45	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.22	10.22	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	10.37	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.05	10.05	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	10.22	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	9.83	9.83	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	10.05	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.05	10.05	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.05	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.22	10.22	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	10.31	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.29	10.29	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.29	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.22	10.22	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	10.29	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.08	10.08	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	10.22	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	9.98	9.98	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	10.08	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	9.83	9.83	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	9.98	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	9.56	9.56	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	9.83	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.08	10.08	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.12	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V$_o$^{2}/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H$_i$ +H$_f$ +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H$_f$ + H$_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	10.90	10.90	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.91	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	10.74	10.74	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	10.90	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	10.42	10.42	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	10.74	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.01	10.01	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	10.42	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	10.90	10.90	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.95	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	11.88	11.88	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.88	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	11.82	11.82	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	11.88	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	11.78	11.78	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	11.82	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	11.45	11.45	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	11.78	10.06	HGL Too High!
P-153	B1	MH-151	1.60	11.78	11.78	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	11.85	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.02	12.02	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	12.07	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	11.57	11.57	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	11.65	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.03	11.03	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	11.57	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	12.73	12.73	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.75	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	12.72	12.72	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.73	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.50	12.50	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	12.72	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.15	12.15	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	12.50	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	11.73	11.73	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	12.15	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.37	11.37	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	11.73	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.02	11.02	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	11.37	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	10.71	10.71	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	11.02	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.26	10.26	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	10.71	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	9.85	9.85	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	10.26	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	9.62	9.62	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	9.85	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.36	9.36	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	9.62	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**9.36**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	9.85	9.85	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.86	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	9.85	9.85	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.86	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	9.62	9.62	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	9.71	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	9.62	9.62	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	9.71	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	9.88	9.88	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	10.76	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.36	9.36	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	9.88	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.50	9.50	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	9.66	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.36	9.36	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	9.50	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	13.90	13.90	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	13.99	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	13.57	13.57	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	13.90	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.14	13.14	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	13.57	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	12.69	12.69	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	13.14	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	11.67	11.67	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	12.69	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.26	10.26	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	11.67	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.08	13.08	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	13.12	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	12.92	12.92	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	13.08	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	12.69	12.69	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	12.92	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.15	11.15	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.15	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.07	11.07	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	11.15	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	10.92	10.92	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	11.07	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	10.75	10.75	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	10.92	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.53	10.53	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	10.75	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	10.75	10.75	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.75	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	10.92	10.92	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	11.01	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	10.99	10.99	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.99	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	10.92	10.92	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	10.99	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	10.78	10.78	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	10.92	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	10.68	10.68	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	10.78	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.53	10.53	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	10.68	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.26	10.26	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	10.53	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	10.78	10.78	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.82	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V$_o$^{2}/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H$_i$ +H$_f$ +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H$_f$ + H$_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	11.60	11.60	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.61	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.44	11.44	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	11.60	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.12	11.12	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	11.44	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	10.71	10.71	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	11.12	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	11.60	11.60	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.65	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	12.58	12.58	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.58	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.52	12.52	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	12.58	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.48	12.48	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	12.52	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.15	12.15	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	12.48	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.48	12.48	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	12.55	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	12.72	12.72	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	12.77	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.27	12.27	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	12.35	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	11.73	11.73	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	12.27	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	13.23	13.23	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.25	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.22	13.22	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.23	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.00	13.00	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	*0.5*	0.08	0.22	13.22	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.65	12.65	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	13.00	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.23	12.23	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	12.65	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.87	11.87	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	*0.5*	0.18	0.35	12.23	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.52	11.52	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	11.87	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.21	11.21	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	11.52	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.76	10.76	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	*0.5*	0.13	0.46	11.21	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.35	10.35	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	*0.5*	0.30	0.40	10.76	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.12	10.12	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	*0.5*	0.14	0.24	10.35	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.86	9.86	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	*0.5*	0.15	0.26	10.12	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	***0.5***	**0.18**	**0.36**	**9.86**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.35	10.35	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.36	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.35	10.35	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.36	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.12	10.12	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.10	10.21	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.12	10.12	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.09	10.21	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.38	10.38	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	11.26	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.86	9.86	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	*1.3*	1.0	0.46	0.52	10.38	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.00	10.00	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	10.16	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.86	9.86	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	*1.3*	1.0	0.11	0.14	10.00	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.40	14.40	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.08	14.49	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.07	14.07	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	*0.5*	0.14	0.33	14.40	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.64	13.64	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	14.07	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.19	13.19	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	13.64	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.17	12.17	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	13.19	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.76	10.76	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	12.17	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.58	13.58	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	13.62	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.42	13.42	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	*0.5*	0.06	0.15	13.58	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.19	13.19	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	*1.3*	1.0	0.10	0.23	13.42	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.65	11.65	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.65	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.57	11.57	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.08	11.65	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.42	11.42	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	*1.3*	1.0	0.05	0.15	11.57	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.25	11.25	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	*0.5*	0.12	0.17	11.42	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.03	11.03	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	11.25	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.25	11.25	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.25	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.42	11.42	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.08	11.51	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.49	11.49	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.49	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.42	11.42	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.07	11.49	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.28	11.28	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	*1.3*	1.0	0.05	0.14	11.42	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.18	11.18	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	*0.5*	0.07	0.10	11.28	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.03	11.03	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	11.18	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.76	10.76	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	*0.5*	0.11	0.27	11.03	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.28	11.28	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	11.32	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.10	12.10	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.11	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.94	11.94	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	12.10	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.62	11.62	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	11.94	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.21	11.21	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	11.62	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.10	12.10	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.15	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.08	13.08	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.08	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.02	13.02	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.08	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.98	12.98	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	13.02	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.65	12.65	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	12.98	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.98	12.98	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	13.05	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.22	13.22	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	13.27	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.77	12.77	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	12.85	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.23	12.23	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	12.77	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)	

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_i + H_i + H_i$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	14.53	14.53	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.55	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	14.52	14.52	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.53	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	14.30	14.30	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	14.52	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.95	13.95	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	14.30	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	13.53	13.53	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	13.95	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	13.17	13.17	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	13.53	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.82	12.82	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	13.17	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.51	12.51	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	12.82	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.06	12.06	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	12.51	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.65	11.65	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	12.06	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.42	11.42	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	11.65	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.16	11.16	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	11.42	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**11.16**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.65	11.65	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.66	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.65	11.65	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.66	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.42	11.42	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	11.51	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.42	11.42	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	11.51	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.68	11.68	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	12.56	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.16	11.16	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	11.68	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.30	11.30	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	11.46	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.16	11.16	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	11.30	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	15.70	15.70	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	15.79	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	15.37	15.37	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	15.70	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.94	14.94	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	15.37	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	14.49	14.49	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	14.94	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.47	13.47	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	14.49	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.06	12.06	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	13.47	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.88	14.88	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	14.92	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.72	14.72	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	14.88	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	14.49	14.49	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	14.72	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.95	12.95	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.95	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.87	12.87	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	12.95	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.72	12.72	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	12.87	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.55	12.55	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	12.72	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.33	12.33	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	12.55	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.55	12.55	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.55	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.72	12.72	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	12.81	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.79	12.79	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.79	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.72	12.72	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	12.79	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.58	12.58	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	12.72	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.48	12.48	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	12.58	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.33	12.33	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	12.48	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.06	12.06	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	12.33	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.58	12.58	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.62	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	13.40	13.40	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.41	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.24	13.24	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	13.40	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.92	12.92	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	13.24	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.51	12.51	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	12.92	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	13.40	13.40	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	13.45	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	14.38	14.38	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.38	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	14.32	14.32	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	14.38	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	14.28	14.28	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	14.32	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.95	13.95	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	14.28	10.06	HGL Too High!
P-153	B1	MH-151	1.60	14.28	14.28	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	14.35	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	14.52	14.52	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	14.57	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	14.07	14.07	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	14.15	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.53	13.53	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	14.07	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date: 2/23/23	Sheet No.: 3 of 5
County:	New Castle	Checked by:	TMC	Date: 3/23/23	Cm. No.: 20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)	

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	9.47	9.47	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.49	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.46	9.46	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.47	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.24	9.24	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	9.46	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	8.89	8.89	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	9.24	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.47	8.47	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	8.89	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.11	8.11	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	8.47	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.76	7.76	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	8.11	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.45	7.45	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	7.76	10.52	HGL ok
P-143	DI-143	MH-170	2.40	7.00	7.00	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	7.45	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.59	6.59	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	7.00	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.36	6.36	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	6.59	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.10	6.10	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	6.36	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**6.10**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.59	6.59	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.60	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.59	6.59	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.60	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.36	6.36	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	6.45	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.36	6.36	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	6.45	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.62	6.62	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	7.50	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.10	6.10	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	6.62	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.24	6.78	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	6.94	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.10	6.10	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	6.24	9.25	HGL ok
P-115	B5 West	MH-116	1.20	10.64	10.64	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	10.73	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.31	10.31	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	10.64	11.99	HGL ok
P-117	DI-117	DI-118	1.20	9.88	9.88	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	10.31	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.43	9.43	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	9.88	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.41	8.41	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	9.43	11.30	HGL ok
P-114	DI-114	MH-170	1.20	7.00	7.00	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	8.41	10.75	HGL ok
P-110	B4 South	MH-111	1.20	9.82	9.82	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	9.86	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.66	9.66	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	9.82	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.43	9.43	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	9.66	11.71	HGL ok
P-120	DI-120	DI-121	1.00	7.89	7.89	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.89	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	7.81	7.81	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	7.89	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.66	7.66	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	7.81	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.49	7.49	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	7.66	8.91	HGL ok
P-124	DI-124	MH-135	1.60	7.27	7.27	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	7.49	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.49	7.49	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.49	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.66	7.66	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	7.75	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.73	7.73	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.73	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.66	7.66	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	7.73	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.52	7.52	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	7.66	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.42	7.42	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	7.52	8.91	HGL ok
P-134	DI-134	MH-135	1.60	7.27	7.27	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	7.42	9.44	HGL ok
P-135	MH-135	MH-170	2.00	7.00	7.00	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	7.27	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.52	7.52	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	7.56	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.34	8.34	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.35	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.18	8.18	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	8.34	10.87	HGL ok
P-146	DI-146	DI-147	1.20	7.86	7.86	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	8.18	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.45	7.45	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	7.86	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.34	8.34	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	8.39	10.00	HGL ok
P-167	DI-167	DI-159	1.00	9.32	9.32	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.32	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.26	9.26	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	9.32	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.22	9.22	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	9.26	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	8.89	8.89	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	9.22	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.22	9.22	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	9.29	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	9.46	9.46	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	9.51	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.01	9.01	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	9.09	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	8.47	8.47	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	9.01	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR   Date: 2/23/23   Sheet No.: 3 of 5
Checked by: TMC   Date: 3/23/23   Cm. No.: 20077
Design Freq.: 500 -year (50-year for sumps)

Location No.	Location From	Location To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	9.67	9.67	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.69	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	9.66	9.66	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.67	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	9.44	9.44	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	*0.5*	0.08	0.22	9.66	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	9.09	9.09	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	9.44	11.07	HGL ok
P-152	DI-152	MH-140	2.00	8.67	8.67	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	9.09	11.07	HGL ok
P-140	MH-140	DI-141	2.40	8.31	8.31	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	*0.5*	0.18	0.35	8.67	12.04	HGL ok
P-141	DI-141	DI-142	2.40	7.96	7.96	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	8.31	11.02	HGL ok
P-142	DI-142	DI-143	2.40	7.65	7.65	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	7.96	10.52	HGL ok
P-143	DI-143	MH-170	2.40	7.20	7.20	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	*0.5*	0.13	0.46	7.65	10.28	HGL ok
P-170	MH-170	MH-171	3.20	6.79	6.79	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	*0.5*	0.30	0.40	7.20	11.16	HGL ok
P-171	MH-171	MH-172	3.20	6.56	6.56	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	*0.5*	0.14	0.24	6.79	10.83	HGL ok
P-172	MH-172	MH-173	3.20	6.30	6.30	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	*0.5*	0.15	0.26	6.56	10.55	HGL ok
P-173	**MH-173**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	***0.5***	**0.18**	**0.36**	**6.30**	**10.22**	**HGL ok**
P-174	DI-174	MH-171	1.20	6.79	6.79	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.80	10.61	HGL ok
P-175	DI-175	MH-171	1.20	6.79	6.79	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.80	10.63	HGL ok
P-176	B4 North	MH-172	1.20	6.56	6.56	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.10	6.65	10.00	HGL ok
P-177	B2 South	MH-172	1.20	6.56	6.56	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.09	6.65	10.00	HGL ok
P-178	TD-03	DI-179	0.53	6.82	6.82	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	7.70	10.50	HGL ok
P-179	DI-179	MH-173	1.00	6.30	6.30	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	*1.3*	1.0	0.46	0.52	6.82	9.25	HGL ok
P-180	TD-02	DI-181	0.53	6.44	6.78	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	6.94	10.50	HGL ok
P-181	DI-181	MH-173	1.00	6.30	6.30	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	*1.3*	1.0	0.11	0.14	6.44	9.25	HGL ok
P-115	B5 West	MH-116	1.20	10.84	10.84	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.08	10.93	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	10.51	10.51	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	*0.5*	0.14	0.33	10.84	11.99	HGL ok
P-117	DI-117	DI-118	1.20	10.08	10.08	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	10.51	11.71	HGL ok
P-118	DI-118	DI-113	1.20	9.63	9.63	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	10.08	11.30	HGL ok
P-113	DI-113	DI-114	1.20	8.61	8.61	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	9.63	11.30	HGL ok
P-114	DI-114	MH-170	1.20	7.20	7.20	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	8.61	10.75	HGL ok
P-110	B4 South	MH-111	1.20	10.02	10.02	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	10.06	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	9.86	9.86	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	*0.5*	0.06	0.15	10.02	11.99	HGL ok
P-112	DI-112	DI-113	1.20	9.63	9.63	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	*1.3*	1.0	0.10	0.23	9.86	11.71	HGL ok
P-120	DI-120	DI-121	1.00	8.09	8.09	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.09	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	8.01	8.01	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.08	8.09	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	7.86	7.86	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	*1.3*	1.0	0.05	0.15	8.01	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	7.69	7.69	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	*0.5*	0.12	0.17	7.86	8.91	HGL ok
P-124	DI-124	MH-135	1.60	7.47	7.47	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	7.69	9.44	HGL ok
P-125	DI-125	DI-124	1.00	7.69	7.69	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.69	10.67	HGL ok
P-126	B5 North	MH-123	1.20	7.86	7.86	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.08	7.95	10.00	HGL ok
P-130	DI-130	DI-131	1.00	7.93	7.93	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.93	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	7.86	7.86	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.07	7.93	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	7.72	7.72	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	*1.3*	1.0	0.05	0.14	7.86	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	7.62	7.62	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	*0.5*	0.07	0.10	7.72	8.91	HGL ok
P-134	DI-134	MH-135	1.60	7.47	7.47	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	7.62	9.44	HGL ok
P-135	MH-135	MH-170	2.00	7.20	7.20	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	*0.5*	0.11	0.27	7.47	10.15	HGL ok
P-136	B3 South	MH-133	1.20	7.72	7.72	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	7.76	10.00	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	8.54	8.54	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.55	11.02	HGL ok
P-145	MH-145	DI-146	1.20	8.38	8.38	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	8.54	10.87	HGL ok
P-146	DI-146	DI-147	1.20	8.06	8.06	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	8.38	10.52	HGL ok
P-147	DI-147	DI-143	1.20	7.65	7.65	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	8.06	10.28	HGL ok
P-148	B3 West	MH-145	1.20	8.54	8.54	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	8.59	10.00	HGL ok
P-167	DI-167	DI-159	1.00	9.52	9.52	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.52	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	9.46	9.46	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	9.52	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	9.42	9.42	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	9.46	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	9.09	9.09	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	9.42	10.06	HGL Too High!
P-153	B1	MH-151	1.60	9.42	9.42	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	9.49	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	9.66	9.66	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	9.71	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	9.21	9.21	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	9.29	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	8.67	8.67	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	9.21	10.50	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 500 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
			0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	13.17	13.17	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.19	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.16	13.16	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.17	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	12.94	12.94	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	13.16	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	12.59	12.59	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	12.94	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.17	12.17	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	12.59	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	11.81	11.81	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	12.17	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.46	11.46	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	11.81	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.15	11.15	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	11.46	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	10.70	10.70	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	11.15	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.29	10.29	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	10.70	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.06	10.06	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	10.29	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	9.80	9.80	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	10.06	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**9.80**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.29	10.29	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.30	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.29	10.29	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.30	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.06	10.06	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	10.15	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.06	10.06	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	10.15	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.32	10.32	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	11.20	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	9.80	9.80	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	10.32	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	9.94	9.94	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	10.10	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	9.80	9.80	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	9.94	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.34	14.34	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	14.43	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.01	14.01	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	14.34	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	13.58	13.58	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	14.01	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.13	13.13	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	13.58	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.11	12.11	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	13.13	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	10.70	10.70	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	12.11	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	13.52	13.52	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	13.56	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.36	13.36	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	13.52	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.13	13.13	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	13.36	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	11.59	11.59	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.59	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	11.51	11.51	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	11.59	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.36	11.36	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	11.51	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.19	11.19	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	11.36	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	10.97	10.97	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	11.19	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.19	11.19	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.19	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.36	11.36	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	11.45	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.43	11.43	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.43	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.36	11.36	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	11.43	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.22	11.22	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	11.36	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.12	11.12	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	11.22	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	10.97	10.97	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	11.12	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	10.70	10.70	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	10.97	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.22	11.22	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.26	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.04	12.04	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.05	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	11.88	11.88	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	12.04	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	11.56	11.56	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	11.88	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.15	11.15	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	11.56	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.04	12.04	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.09	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.02	13.02	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.02	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	12.96	12.96	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.02	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	12.92	12.92	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	12.96	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	12.59	12.59	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	12.92	10.06	HGL Too High!
P-153	B1	MH-151	1.60	12.92	12.92	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	12.99	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.16	13.16	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	13.21	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	12.71	12.71	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	12.79	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.17	12.17	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	12.71	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 500 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat[ure] (O, deg)	Curved align; add Hc = $0.002*O*V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H=H_f+H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	13.67	13.67	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.69	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	13.66	13.66	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.67	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	13.44	13.44	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	13.66	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.09	13.09	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	13.44	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	12.67	12.67	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	13.09	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	12.31	12.31	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	12.67	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	11.96	11.96	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	12.31	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	11.65	11.65	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	11.96	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	11.20	11.20	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	11.65	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	10.79	10.79	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	11.20	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	10.56	10.56	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	10.79	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	10.30	10.30	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	10.56	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**10.30**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	10.79	10.79	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.80	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	10.79	10.79	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.80	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	10.56	10.56	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	10.65	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	10.56	10.56	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	10.65	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	10.82	10.82	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	11.70	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	10.30	10.30	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	10.82	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	10.44	10.44	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	10.60	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	10.30	10.30	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	10.44	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	14.84	14.84	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	14.93	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	14.51	14.51	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	14.84	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.08	14.08	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	14.51	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	13.63	13.63	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	14.08	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	12.61	12.61	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	13.63	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	11.20	11.20	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	12.61	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.02	14.02	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	14.06	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	13.86	13.86	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	14.02	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	13.63	13.63	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	13.86	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.09	12.09	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.09	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.01	12.01	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	12.09	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	11.86	11.86	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	12.01	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	11.69	11.69	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	11.86	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	11.47	11.47	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	11.69	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	11.69	11.69	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.69	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	11.86	11.86	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	11.95	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	11.93	11.93	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.93	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	11.86	11.86	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	11.93	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	11.72	11.72	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	11.86	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	11.62	11.62	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	11.72	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	11.47	11.47	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	11.62	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	11.20	11.20	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	11.47	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	11.72	11.72	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.76	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.54	12.54	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.55	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.38	12.38	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	12.54	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.06	12.06	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	12.38	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	11.65	11.65	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	12.06	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.54	12.54	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.59	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.52	13.52	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.52	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.46	13.46	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.52	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.42	13.42	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	13.46	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.09	13.09	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	13.42	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.42	13.42	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	13.49	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	13.66	13.66	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	13.71	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.21	13.21	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	13.29	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	12.67	12.67	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	13.21	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L
			ft	ft	ft	in	cfs	fps	deg	ft
P-158	DI-158	DI-154	1.00	14.07	14.07	15	0.8	0.7	96	100
P-154	DI-154	MH-155	1.00	14.06	14.06	15	1.4	1.1	10	24
P-155	MH-155	DI-156	1.20	13.84	13.84	18	6.0	3.4	89	51
P-156	DI-156	DI-152	1.20	13.49	13.49	18	6.5	3.7	94	33
P-152	DI-152	MH-140	2.00	13.07	13.07	30	20.7	4.2	85	97
P-140	MH-140	DI-141	2.40	12.71	12.71	36	30.6	4.3	2	97
P-141	DI-141	DI-142	2.40	12.36	12.36	36	30.9	4.4	1	96
P-142	DI-142	DI-143	2.40	12.05	12.05	36	31.4	4.4	5	68
P-143	DI-143	MH-170	2.40	11.60	11.60	36	38.6	5.5	86	115
P-170	MH-170	MH-171	3.20	11.19	11.19	48	68.1	5.4	0	55
P-171	MH-171	MH-172	3.20	10.96	10.96	48	69.0	5.5	0	50
P-172	MH-172	MH-173	3.20	10.70	10.70	48	76.5	6.1	0	44
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**81.5**	**6.5**	**0**	**64**
P-174	DI-174	MH-171	1.20	11.19	11.19	18	0.8	0.5	90	33
P-175	DI-175	MH-171	1.20	11.19	11.19	18	0.9	0.5	90	33
P-176	B4 North	MH-172	1.20	10.96	10.96	18	4.4	2.5	90	55
P-177	B2 South	MH-172	1.20	10.96	10.96	18	4.3	2.4	90	55
P-178	TD-03	DI-179	0.53	11.22	11.22	8	1.7	4.9	56	56
P-179	DI-179	MH-173	1.00	10.70	10.70	15	3.3	2.7	90	30
P-180	TD-02	DI-181	0.53	10.84	10.84	8	0.8	2.3	45	45
P-181	DI-181	MH-173	1.00	10.70	10.70	15	2.4	1.9	90	30
P-115	B5 West	MH-116	1.20	15.24	15.24	18	6.5	3.7	86	17
P-116	MH-116	DI-117	1.20	14.91	14.91	18	6.5	3.7	4	60
P-117	DI-117	DI-118	1.20	14.48	14.48	18	7.0	4.0	89	71
P-118	DI-118	DI-113	1.20	14.03	14.03	18	7.6	4.3	72	27
P-113	DI-113	DI-114	1.20	13.01	13.01	18	13.0	7.4	25	41
P-114	DI-114	MH-170	1.20	11.60	11.60	18	13.3	7.5	97	47
P-110	B4 South	MH-111	1.20	14.42	14.42	18	4.4	2.5	86	17
P-111	MH-111	DI-112	1.20	14.26	14.26	18	4.4	2.5	4	60
P-112	DI-112	DI-113	1.20	14.03	14.03	18	5.0	2.8	19	71
P-120	DI-120	DI-121	1.00	12.49	12.49	15	0.6	0.5	2	22
P-121	DI-121	DI-122	1.00	12.41	12.41	15	1.9	1.6	7	84
P-122	DI-122	MH-123	1.00	12.26	12.26	15	2.9	2.4	14	56
P-123	MH-123	DI-124	1.60	12.09	12.09	24	9.1	2.9	81	36
P-124	DI-124	MH-135	1.60	11.87	11.87	24	10.1	3.2	90	31
P-125	DI-125	DI-124	1.00	12.09	12.09	15	0.3	0.3	71	45
P-126	B5 North	MH-123	1.20	12.26	12.26	18	6.5	3.7	81	17
P-130	DI-130	DI-131	1.00	12.33	12.33	15	0.6	0.5	6	22
P-131	DI-131	DI-132	1.00	12.26	12.26	15	1.8	1.5	5	83
P-132	DI-132	MH-133	1.00	12.12	12.12	15	2.9	2.3	14	56
P-133	MH-133	DI-134	1.60	12.02	12.02	24	7.4	2.4	81	36
P-134	DI-134	MH-135	1.60	11.87	11.87	24	8.2	2.6	90	31
P-135	MH-135	MH-170	2.00	11.60	11.60	30	18.3	3.7	0	94
P-136	B3 South	MH-133	1.20	12.12	12.12	18	4.8	2.7	81	17

No.	From	To	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity
No.	From	To	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi
			ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2	
P-158	DI-158	DI-154	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0
P-154	DI-154	MH-155	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0
P-155	MH-155	DI-156	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7
P-156	DI-156	DI-152	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4
P-152	DI-152	MH-140	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5
P-140	MH-140	DI-141	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2
P-141	DI-141	DI-142	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3
P-142	DI-142	DI-143	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4
P-143	DI-143	MH-170	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4
P-170	MH-170	MH-171	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5
P-171	MH-171	MH-172	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4
P-172	MH-172	MH-173	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5
P-173	**MH-173**	**OUTFALL**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**
P-174	DI-174	MH-171	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0
P-175	DI-175	MH-171	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0
P-176	B4 North	MH-172	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0
P-177	B2 South	MH-172	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0
P-178	TD-03	DI-179	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0
P-179	DI-179	MH-173	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9
P-180	TD-02	DI-181	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0
P-181	DI-181	MH-173	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3
P-115	B5 West	MH-116	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0
P-116	MH-116	DI-117	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7
P-117	DI-117	DI-118	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7
P-118	DI-118	DI-113	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0
P-113	DI-113	DI-114	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3
P-114	DI-114	MH-170	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4
P-110	B4 South	MH-111	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0
P-111	MH-111	DI-112	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5
P-112	DI-112	DI-113	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5
P-120	DI-120	DI-121	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0
P-121	DI-121	DI-122	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5
P-122	DI-122	MH-123	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6
P-123	MH-123	DI-124	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7
P-124	DI-124	MH-135	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9
P-125	DI-125	DI-124	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0
P-126	B5 North	MH-123	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0
P-130	DI-130	DI-131	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0
P-131	DI-131	DI-132	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5
P-132	DI-132	MH-133	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5
P-133	MH-133	DI-134	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7
P-134	DI-134	MH-135	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4
P-135	MH-135	MH-170	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2
P-136	B3 South	MH-133	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0

No.	From	To	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\ adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	Hi	Δ_i	H_Δ	H_t			$H_{t\ adj}$	H	HGL Up	T/G	
			ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.09	7.70	HGL Too High!
P-154	DI-154	MH-155	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.07	9.06	HGL Too High!
P-155	MH-155	DI-156	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	14.06	10.06	HGL Too High!
P-156	DI-156	DI-152	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	13.84	11.07	HGL Too High!
P-152	DI-152	MH-140	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	13.49	11.07	HGL Too High!
P-140	MH-140	DI-141	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	13.07	12.04	HGL Too High!
P-141	DI-141	DI-142	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	12.71	11.02	HGL Too High!
P-142	DI-142	DI-143	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	12.36	10.52	HGL Too High!
P-143	DI-143	MH-170	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	12.05	10.28	HGL Too High!
P-170	MH-170	MH-171	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	11.60	11.16	HGL Too High!
P-171	MH-171	MH-172	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	11.19	10.83	HGL Too High!
P-172	MH-172	MH-173	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	10.96	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**10.70**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.20	10.61	HGL Too High!
P-175	DI-175	MH-171	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.20	10.63	HGL Too High!
P-176	B4 North	MH-172	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	11.05	10.00	HGL Too High!
P-177	B2 South	MH-172	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	11.05	10.00	HGL Too High!
P-178	TD-03	DI-179	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	12.10	10.50	HGL Too High!
P-179	DI-179	MH-173	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	11.22	9.25	HGL Too High!
P-180	TD-02	DI-181	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	11.00	10.50	HGL Too High!
P-181	DI-181	MH-173	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	10.84	9.25	HGL Too High!
P-115	B5 West	MH-116	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	15.33	10.00	HGL Too High!
P-116	MH-116	DI-117	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	15.24	11.99	HGL Too High!
P-117	DI-117	DI-118	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	14.91	11.71	HGL Too High!
P-118	DI-118	DI-113	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	14.48	11.30	HGL Too High!
P-113	DI-113	DI-114	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	14.03	11.30	HGL Too High!
P-114	DI-114	MH-170	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	13.01	10.75	HGL Too High!
P-110	B4 South	MH-111	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	14.46	10.00	HGL Too High!
P-111	MH-111	DI-112	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	14.42	11.99	HGL Too High!
P-112	DI-112	DI-113	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	14.26	11.71	HGL Too High!
P-120	DI-120	DI-121	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.49	7.10	HGL Too High!
P-121	DI-121	DI-122	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	12.49	7.05	HGL Too High!
P-122	DI-122	MH-123	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	12.41	7.81	HGL Too High!
P-123	MH-123	DI-124	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	12.26	8.91	HGL Too High!
P-124	DI-124	MH-135	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	12.09	9.44	HGL Too High!
P-125	DI-125	DI-124	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.09	10.67	HGL Too High!
P-126	B5 North	MH-123	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	12.35	10.00	HGL Too High!
P-130	DI-130	DI-131	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.33	7.10	HGL Too High!
P-131	DI-131	DI-132	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	12.33	7.15	HGL Too High!
P-132	DI-132	MH-133	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	12.26	7.81	HGL Too High!
P-133	MH-133	DI-134	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	12.12	8.91	HGL Too High!
P-134	DI-134	MH-135	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	12.02	9.44	HGL Too High!
P-135	MH-135	MH-170	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	11.87	10.15	HGL Too High!
P-136	B3 South	MH-133	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.16	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V$_o$^{2}/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H$_f$ +H$_i$ +H$_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H$_f$ + H$_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	12.94	12.94	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.95	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	12.78	12.78	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	12.94	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.46	12.46	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	12.78	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.05	12.05	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	12.46	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	12.94	12.94	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.99	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	13.92	13.92	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.92	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	13.86	13.86	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	13.92	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	13.82	13.82	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	13.86	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.49	13.49	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	13.82	10.06	HGL Too High!
P-153	B1	MH-151	1.60	13.82	13.82	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	13.89	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	14.06	14.06	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	14.11	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	13.61	13.61	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	13.69	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.07	13.07	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	13.61	10.50	HGL Too High!

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23
Checked by: TMC Date: 3/23/23
Design Freq.: 500 -year (50-year for sumps)

Cm. No.: 20077

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, link to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel., $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvat… (O, deg)	Curved align; add Hc = $0.002 \cdot O \cdot V_o^2/2g$ (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P-158	DI-158	DI-154	1.00	14.57	14.57	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.59	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	14.56	14.56	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.57	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	14.34	14.34	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	14.56	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	13.99	13.99	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	14.34	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	13.57	13.57	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	13.99	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	13.21	13.21	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	13.57	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	12.86	12.86	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	13.21	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	12.55	12.55	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	12.86	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.10	12.10	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	12.55	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	11.69	11.69	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	12.10	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	11.46	11.46	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	11.69	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.20	11.20	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	11.46	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**11.20**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	11.69	11.69	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.70	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	11.69	11.69	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.70	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	11.46	11.46	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	11.55	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	11.46	11.46	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	11.55	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	11.72	11.72	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	12.60	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.20	11.20	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	11.72	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	11.34	11.34	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	11.50	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.20	11.20	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	11.34	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	15.74	15.74	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	15.83	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	15.41	15.41	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	15.74	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	14.98	14.98	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	15.41	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	14.53	14.53	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	14.98	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	13.51	13.51	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	14.53	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.10	12.10	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	13.51	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	14.92	14.92	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	14.96	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	14.76	14.76	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	14.92	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	14.53	14.53	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	14.76	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	12.99	12.99	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.99	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	12.91	12.91	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	12.99	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	12.76	12.76	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	12.91	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	12.59	12.59	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	12.76	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	12.37	12.37	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	12.59	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	12.59	12.59	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.59	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	12.76	12.76	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	12.85	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	12.83	12.83	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.83	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	12.76	12.76	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	12.83	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	12.62	12.62	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	12.76	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	12.52	12.52	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	12.62	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	12.37	12.37	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	12.52	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.10	12.10	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	12.37	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	12.62	12.62	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.66	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hf +Hi +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	13.44	13.44	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.45	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.28	13.28	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	13.44	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	12.96	12.96	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	13.28	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	12.55	12.55	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	12.96	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	13.44	13.44	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	13.49	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	14.42	14.42	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.42	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	14.36	14.36	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	14.42	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	14.32	14.32	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	14.36	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	13.99	13.99	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	14.32	10.06	HGL Too High!
P-153	B1	MH-151	1.60	14.32	14.32	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	14.39	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	14.56	14.56	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	14.61	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	14.11	14.11	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	14.19	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	13.57	13.57	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	14.11	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR Date: 2/23/23 Sheet No.: 3 of 5
Checked by: TMC Date: 3/23/23 Cm. No.: 20077
Design Freq.: 500 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D 0.8D ft	Tailwater, link to Inlet WSE of downstream pipe TW ft	Outlet W. S. Elevation HGL Dn ft	Outflow Pipe Diameter D_o in	Outflow Pipe Design Flow Q_o cfs	Pressure-flow Vel., $V_o=Q_o/A$ V_o fps	Skew angle vs. Δ_o deg	Outflow Pipe Length L ft	Friction Slope S_{fo} ft/ft	Friction Loss H_f ft	Angle of Curvat O deg	Curved align; add Hc = $0.002*O*V_o^2/2g$ H_c ft	Contraction Loss H_o ft	Q*V for determining controlling inflow pipe Q1V1 ft^4/s^2	Q*V for determining controlling inflow pipe Q2V2 ft^4/s^2	Q*V for determining controlling inflow pipe Q3V3 ft^4/s^2	Controlling Inflow Velocity Vi	Expansion Loss Hi ft	Controlling In-flow skew Δ_i deg	Bend Loss H_Δ ft	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$ H_t cfs	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB)	Adjusted Junction Loss $H_{t\,adj}$ ft	Tot. H Loss, $H = H_f + H_{t\,adj}$ H ft	Inlet W. S. Elevation HGL Up ft	Top of Grate T/G ft	HGL Check
P-158	DI-158	DI-154	1.00	15.27	15.27	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.29	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	15.26	15.26	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.27	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	15.04	15.04	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	0.5	0.08	0.22	15.26	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	14.69	14.69	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	15.04	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	14.27	14.27	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	14.69	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	13.91	13.91	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	0.5	0.18	0.35	14.27	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	13.56	13.56	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	13.91	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	13.25	13.25	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	13.56	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	12.80	12.80	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	0.5	0.13	0.46	13.25	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.39	12.39	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	0.5	0.30	0.40	12.80	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	12.16	12.16	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	12.39	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	11.90	11.90	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	0.5	0.15	0.26	12.16	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	**0.5**	**0.18**	**0.36**	**11.90**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.39	12.39	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.40	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.39	12.39	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.40	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	12.16	12.16	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.10	12.25	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	12.16	12.16	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.09	12.25	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.42	12.42	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	13.30	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	11.90	11.90	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	1.3	1.0	0.46	0.52	12.42	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	12.04	12.04	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	12.20	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	11.90	11.90	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	1.3	1.0	0.11	0.14	12.04	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	16.44	16.44	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	16.53	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	16.11	16.11	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	0.5	0.14	0.33	16.44	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	15.68	15.68	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	16.11	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	15.23	15.23	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	15.68	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	14.21	14.21	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	15.23	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	12.80	12.80	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	14.21	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	15.62	15.62	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.04	15.66	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	15.46	15.46	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	0.5	0.06	0.15	15.62	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	15.23	15.23	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	1.3	1.0	0.10	0.23	15.46	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	13.69	13.69	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.69	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	13.61	13.61	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	1.3	1.0	0.01	0.08	13.69	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	13.46	13.46	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	1.3	1.0	0.05	0.15	13.61	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	13.29	13.29	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	0.5	0.12	0.17	13.46	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	13.07	13.07	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	13.29	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	13.29	13.29	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.29	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	13.46	13.46	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	0.5	0.03	0.08	13.55	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	13.53	13.53	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.53	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	13.46	13.46	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	1.3	1.0	0.01	0.07	13.53	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	13.32	13.32	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	1.3	1.0	0.05	0.14	13.46	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	13.22	13.22	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	0.5	0.07	0.10	13.32	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	13.07	13.07	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	13.22	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	12.80	12.80	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	0.5	0.11	0.27	13.07	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	13.32	13.32	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	13.36	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= H +H +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	14.14	14.14	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.15	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	13.98	13.98	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	14.14	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	13.66	13.66	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	13.98	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	13.25	13.25	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	13.66	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	14.14	14.14	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	14.19	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	15.12	15.12	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.12	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	15.06	15.06	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	15.12	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	15.02	15.02	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	15.06	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	14.69	14.69	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	15.02	10.06	HGL Too High!
P-153	B1	MH-151	1.60	15.02	15.02	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	15.09	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	15.26	15.26	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	15.31	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	14.81	14.81	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	14.89	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	14.27	14.27	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	14.81	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3	of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077	
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)				

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	**HGL Check**
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	15.77	15.77	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.79	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	15.76	15.76	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.77	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	15.54	15.54	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	*0.5*	0.08	0.22	15.76	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	15.19	15.19	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	15.54	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	14.77	14.77	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	15.19	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	14.41	14.41	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	*0.5*	0.18	0.35	14.77	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	14.06	14.06	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	14.41	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	13.75	13.75	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	14.06	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	13.30	13.30	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	*0.5*	0.13	0.46	13.75	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	12.89	12.89	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	*0.5*	0.30	0.40	13.30	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	12.66	12.66	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	*0.5*	0.14	0.24	12.89	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	12.40	12.40	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	*0.5*	0.15	0.26	12.66	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	***0.5***	**0.18**	**0.36**	**12.40**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	12.89	12.89	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.90	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	12.89	12.89	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.90	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	12.66	12.66	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.10	12.75	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	12.66	12.66	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.09	12.75	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	12.92	12.92	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	13.80	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	12.40	12.40	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	*1.3*	1.0	0.46	0.52	12.92	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	12.54	12.54	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	12.70	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	12.40	12.40	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	*1.3*	1.0	0.11	0.14	12.54	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	16.94	16.94	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.08	17.03	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	16.61	16.61	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	*0.5*	0.14	0.33	16.94	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	16.18	16.18	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	16.61	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	15.73	15.73	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	16.18	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	14.71	14.71	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	15.73	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	13.30	13.30	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	14.71	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	16.12	16.12	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	16.16	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	15.96	15.96	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	*0.5*	0.06	0.15	16.12	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	15.73	15.73	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	*1.3*	1.0	0.10	0.23	15.96	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	14.19	14.19	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.19	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	14.11	14.11	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.08	14.19	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	13.96	13.96	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	*1.3*	1.0	0.05	0.15	14.11	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	13.79	13.79	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	*0.5*	0.12	0.17	13.96	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	13.57	13.57	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	13.79	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	13.79	13.79	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.79	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	13.96	13.96	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.08	14.05	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	14.03	14.03	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.03	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	13.96	13.96	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.07	14.03	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	13.82	13.82	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	*1.3*	1.0	0.05	0.14	13.96	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	13.72	13.72	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	*0.5*	0.07	0.10	13.82	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	13.57	13.57	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	13.72	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	13.30	13.30	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	*0.5*	0.11	0.27	13.57	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	13.82	13.82	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	13.86	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	14.64	14.64	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.65	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	14.48	14.48	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	14.64	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	14.16	14.16	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	14.48	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	13.75	13.75	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	14.16	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	14.64	14.64	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	14.69	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	15.62	15.62	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.62	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	15.56	15.56	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	15.62	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	15.52	15.52	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	15.56	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	15.19	15.19	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	15.52	10.06	HGL Too High!
P-153	B1	MH-151	1.60	15.52	15.52	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	15.59	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	15.76	15.76	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	15.81	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	15.31	15.31	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	15.39	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	14.77	14.77	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	15.31	10.50	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project: South Market Street Infrastructure Improvements
County: New Castle
Segment: East Bank Blvd Outfall

Prepared by: SNR — Date: 2/23/23 — Sheet No.: 3 of 5
Checked by: TMC — Date: 3/23/23 — Cm. No.: 20077
Design Freq.: 500 -year (50-year for sumps)

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align; add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t=H_o+H_i+H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\ adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
			0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\ adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-158	DI-158	DI-154	1.00	17.07	17.07	15	0.8	0.7	96	100	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.09	7.70	HGL Too High!
P-154	DI-154	MH-155	1.00	17.06	17.06	15	1.4	1.1	10	24	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.07	9.06	HGL Too High!
P-155	MH-155	DI-156	1.20	16.84	16.84	18	6.0	3.4	89	51	0.0028	0.14	0	0.00	0.04	1.5	13.0	0.0	2.7	0.0	89	0.08	0.17	1.0	*0.5*	0.08	0.22	17.06	10.06	HGL Too High!
P-156	DI-156	DI-152	1.20	16.49	16.49	18	6.5	3.7	94	33	0.0032	0.11	0	0.00	0.05	20.4	0.0	0.0	3.4	0.1	89	0.13	0.24	1.0	1.0	0.24	0.35	16.84	11.07	HGL Too High!
P-152	DI-152	MH-140	2.00	16.07	16.07	30	20.7	4.2	85	97	0.0022	0.21	0	0.00	0.07	23.7	64.1	0.0	4.5	0.1	3	0.03	0.21	1.0	1.0	0.21	0.42	16.49	11.07	HGL Too High!
P-140	MH-140	DI-141	2.40	15.71	15.71	36	30.6	4.3	2	97	0.0018	0.17	0	0.00	0.07	87.5	64.8	0.0	4.2	0.1	85	0.19	0.36	1.0	*0.5*	0.18	0.35	16.07	12.04	HGL Too High!
P-141	DI-141	DI-142	2.40	15.36	15.36	36	30.9	4.4	1	96	0.0018	0.18	0	0.00	0.07	132.7	0.0	0.0	4.3	0.1	2	0.00	0.18	1.0	1.0	0.18	0.35	15.71	11.02	HGL Too High!
P-142	DI-142	DI-143	2.40	15.05	15.05	36	31.4	4.4	5	68	0.0019	0.13	0	0.00	0.08	135.5	0.0	0.0	4.4	0.1	1	0.00	0.18	1.0	1.0	0.18	0.31	15.36	10.52	HGL Too High!
P-143	DI-143	MH-170	2.40	14.60	14.60	36	38.6	5.5	86	115	0.0029	0.33	0	0.00	0.12	139.1	27.1	0.0	4.4	0.1	5	0.03	0.25	1.0	*0.5*	0.13	0.46	15.05	10.28	HGL Too High!
P-170	MH-170	MH-171	3.20	14.19	14.19	48	68.1	5.4	0	55	0.0019	0.11	0	0.00	0.11	211.2	100.6	68.0	5.5	0.2	86	0.32	0.59	1.0	*0.5*	0.30	0.40	14.60	11.16	HGL Too High!
P-171	MH-171	MH-172	3.20	13.96	13.96	48	69.0	5.5	0	50	0.0020	0.10	0	0.00	0.12	369.4	0.4	0.5	5.4	0.2	0	0.00	0.28	1.0	*0.5*	0.14	0.24	14.19	10.83	HGL Too High!
P-172	MH-172	MH-173	3.20	13.70	13.70	48	76.5	6.1	0	44	0.0024	0.11	0	0.00	0.14	379.0	11.2	10.3	5.5	0.2	0	0.00	0.31	1.0	*0.5*	0.15	0.26	13.96	10.55	HGL Too High!
P-173	**MH-173**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**81.5**	**6.5**	**0**	**64**	**0.0027**	**0.18**	**0**	**0.00**	**0.16**	**465.4**	**8.8**	**4.5**	**6.1**	**0.2**	**0**	**0.00**	**0.36**	**1.0**	***0.5***	**0.18**	**0.36**	**13.70**	**10.22**	**HGL Too High!**
P-174	DI-174	MH-171	1.20	14.19	14.19	18	0.8	0.5	90	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.20	10.61	HGL Too High!
P-175	DI-175	MH-171	1.20	14.19	14.19	18	0.9	0.5	90	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.20	10.63	HGL Too High!
P-176	B4 North	MH-172	1.20	13.96	13.96	18	4.4	2.5	90	55	0.0015	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.10	14.05	10.00	HGL Too High!
P-177	B2 South	MH-172	1.20	13.96	13.96	18	4.3	2.4	90	55	0.0014	0.08	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.09	14.05	10.00	HGL Too High!
P-178	TD-03	DI-179	0.53	14.22	14.22	8	1.7	4.9	56	56	0.0141	0.79	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.88	15.10	10.50	HGL Too High!
P-179	DI-179	MH-173	1.00	13.70	13.70	15	3.3	2.7	90	30	0.0022	0.07	0	0.00	0.03	8.2	0.0	0.0	4.9	0.1	56	0.19	0.35	*1.3*	1.0	0.46	0.52	14.22	9.25	HGL Too High!
P-180	TD-02	DI-181	0.53	13.84	13.84	8	0.8	2.3	45	45	0.0031	0.14	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.16	14.00	10.50	HGL Too High!
P-181	DI-181	MH-173	1.00	13.70	13.70	15	2.4	1.9	90	30	0.0011	0.03	0	0.00	0.01	1.8	0.0	0.0	2.3	0.0	45	0.04	0.08	*1.3*	1.0	0.11	0.14	13.84	9.25	HGL Too High!
P-115	B5 West	MH-116	1.20	18.24	18.24	18	6.5	3.7	86	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.08	18.33	10.00	HGL Too High!
P-116	MH-116	DI-117	1.20	17.91	17.91	18	6.5	3.7	4	60	0.0033	0.20	0	0.00	0.05	24.2	0.0	0.0	3.7	0.1	86	0.14	0.27	1.0	*0.5*	0.14	0.33	18.24	11.99	HGL Too High!
P-117	DI-117	DI-118	1.20	17.48	17.48	18	7.0	4.0	89	71	0.0038	0.27	0	0.00	0.06	24.0	0.0	0.0	3.7	0.1	4	0.02	0.16	1.0	1.0	0.16	0.43	17.91	11.71	HGL Too High!
P-118	DI-118	DI-113	1.20	17.03	17.03	18	7.6	4.3	72	27	0.0044	0.12	0	0.00	0.07	28.1	0.0	0.0	4.0	0.1	89	0.17	0.33	1.0	1.0	0.33	0.45	17.48	11.30	HGL Too High!
P-113	DI-113	DI-114	1.20	16.01	16.01	18	13.0	7.4	25	41	0.0131	0.54	0	0.00	0.21	32.4	14.0	0.0	4.3	0.1	72	0.17	0.48	1.0	1.0	0.48	1.02	17.03	11.30	HGL Too High!
P-114	DI-114	MH-170	1.20	14.60	14.60	18	13.3	7.5	97	47	0.0137	0.65	0	0.00	0.22	96.0	0.0	0.0	7.4	0.3	25	0.25	0.77	1.0	1.0	0.77	1.41	16.01	10.75	HGL Too High!
P-110	B4 South	MH-111	1.20	17.42	17.42	18	4.4	2.5	86	17	0.0015	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	*0.5*	0.01	0.04	17.46	10.00	HGL Too High!
P-111	MH-111	DI-112	1.20	17.26	17.26	18	4.4	2.5	4	60	0.0015	0.09	0	0.00	0.02	11.2	0.0	0.0	2.5	0.0	86	0.07	0.13	1.0	*0.5*	0.06	0.15	17.42	11.99	HGL Too High!
P-112	DI-112	DI-113	1.20	17.03	17.03	18	5.0	2.8	19	71	0.0019	0.14	0	0.00	0.03	11.1	0.0	0.0	2.5	0.0	4	0.01	0.07	*1.3*	1.0	0.10	0.23	17.26	11.71	HGL Too High!
P-120	DI-120	DI-121	1.00	15.49	15.49	15	0.6	0.5	2	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.49	7.10	HGL Too High!
P-121	DI-121	DI-122	1.00	15.41	15.41	15	1.9	1.6	7	84	0.0008	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	2	0.00	0.01	*1.3*	1.0	0.01	0.08	15.49	7.05	HGL Too High!
P-122	DI-122	MH-123	1.00	15.26	15.26	15	2.9	2.4	14	56	0.0018	0.10	0	0.00	0.02	3.0	0.0	0.0	1.6	0.0	7	0.00	0.04	*1.3*	1.0	0.05	0.15	15.41	7.81	HGL Too High!
P-123	MH-123	DI-124	1.60	15.09	15.09	24	9.1	2.9	81	36	0.0014	0.05	0	0.00	0.03	7.0	23.9	0.0	3.7	0.1	81	0.14	0.25	1.0	*0.5*	0.12	0.17	15.26	8.91	HGL Too High!
P-124	DI-124	MH-135	1.60	14.87	14.87	24	10.1	3.2	90	31	0.0017	0.05	0	0.00	0.04	26.6	0.1	0.0	2.9	0.0	81	0.09	0.17	1.0	1.0	0.17	0.23	15.09	9.44	HGL Too High!
P-125	DI-125	DI-124	1.00	15.09	15.09	15	0.3	0.3	71	45	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.09	10.67	HGL Too High!
P-126	B5 North	MH-123	1.20	15.26	15.26	18	6.5	3.7	81	17	0.0033	0.06	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	*0.5*	0.03	0.08	15.35	10.00	HGL Too High!
P-130	DI-130	DI-131	1.00	15.33	15.33	15	0.6	0.5	6	22	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.33	7.10	HGL Too High!
P-131	DI-131	DI-132	1.00	15.26	15.26	15	1.8	1.5	5	83	0.0007	0.06	0	0.00	0.01	0.3	0.0	0.0	0.5	0.0	6	0.00	0.01	*1.3*	1.0	0.01	0.07	15.33	7.15	HGL Too High!
P-132	DI-132	MH-133	1.00	15.12	15.12	15	2.9	2.3	14	56	0.0017	0.09	0	0.00	0.02	2.7	0.0	0.0	1.5	0.0	5	0.00	0.04	*1.3*	1.0	0.05	0.14	15.26	7.81	HGL Too High!
P-133	MH-133	DI-134	1.60	15.02	15.02	24	7.4	2.4	81	36	0.0009	0.03	0	0.00	0.02	6.7	13.0	0.0	2.7	0.0	81	0.08	0.14	1.0	*0.5*	0.07	0.10	15.12	8.91	HGL Too High!
P-134	DI-134	MH-135	1.60	14.87	14.87	24	8.2	2.6	90	31	0.0011	0.04	0	0.00	0.03	17.6	0.0	0.0	2.4	0.0	81	0.06	0.11	1.0	1.0	0.11	0.15	15.02	9.44	HGL Too High!
P-135	MH-135	MH-170	2.00	14.60	14.60	30	18.3	3.7	0	94	0.0017	0.16	0	0.00	0.05	21.7	32.5	0.0	3.2	0.1	90	0.11	0.22	1.0	*0.5*	0.11	0.27	14.87	10.15	HGL Too High!
P-136	B3 South	MH-133	1.20	15.12	15.12	18	4.8	2.7	81	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	*0.5*	0.01	0.04	15.16	10.00	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	3 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	East Bank Blvd Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvat	Curved align: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, Ht= Hi +Hj +H	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for Inlet, 0.5 for MH or JB	Adjusted Junction Loss	Tot. H Loss, H = H_f + $H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P-144	DI-144	MH-145	1.00	15.94	15.94	15	0.5	0.4	12	55	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.95	11.02	HGL Too High!
P-145	MH-145	DI-146	1.20	15.78	15.78	18	5.2	3.0	7	39	0.0021	0.08	0	0.00	0.03	0.2	13.0	0.0	2.7	0.0	83	0.08	0.15	1.0	0.5	0.08	0.16	15.94	10.87	HGL Too High!
P-146	DI-146	DI-147	1.20	15.46	15.46	18	5.9	3.4	89	68	0.0027	0.19	0	0.00	0.04	15.5	0.0	0.0	3.0	0.0	7	0.01	0.11	1.3	1.0	0.14	0.32	15.78	10.52	HGL Too High!
P-147	DI-147	DI-143	1.20	15.05	15.05	18	6.9	3.9	86	25	0.0037	0.09	0	0.00	0.06	20.0	0.0	0.0	3.4	0.1	89	0.12	0.24	1.3	1.0	0.32	0.41	15.46	10.28	HGL Too High!
P-148	B3 West	MH-145	1.20	15.94	15.94	18	4.8	2.7	83	17	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	15.99	10.00	HGL Too High!
P-167	DI-167	DI-159	1.00	16.92	16.92	15	0.8	0.7	49	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.92	7.48	HGL Too High!
P-159	DI-159	DI-150	1.00	16.86	16.86	15	1.6	1.3	47	100	0.0005	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	16.92	7.70	HGL Too High!
P-150	DI-150	MH-151	1.00	16.82	16.82	15	2.2	1.8	10	24	0.0010	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	16.86	9.06	HGL Too High!
P-151	MH-151	DI-152	1.60	16.49	16.49	24	14.2	4.5	3	51	0.0034	0.17	0	0.00	0.08	4.0	46.2	0.0	3.8	0.1	89	0.16	0.32	1.0	0.5	0.16	0.33	16.82	10.06	HGL Too High!
P-153	B1	MH-151	1.60	16.82	16.82	24	12.0	3.8	89	17	0.0024	0.04	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	0.5	0.03	0.07	16.89	10.00	HGL Too High!
P-157	B3 North	MH-155	1.20	17.06	17.06	18	4.8	2.7	89	18	0.0018	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	17.11	10.00	HGL Too High!
P-166	B2 North	MH-163	1.20	16.61	16.61	18	4.2	2.4	90	50	0.0014	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.08	16.69	10.00	HGL Too High!
P-163	MH-163	MH-140	1.20	16.07	16.07	18	10.7	6.1	92	44	0.0088	0.39	0	0.00	0.14	10.1	0.0	10.1	2.4	0.0	90	0.06	0.24	1.3	0.5	0.15	0.54	16.61	10.50	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 5 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: Market Street Outfall (North) | Storm Frequency: 1 -year (50-year for sumps)
4

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P33	DI24	MH13	4615	1621	6236	0.14	0.75	0.11	0.11	6.0	6.17	3.98	0.4	15	30	0.012	0.0000	0.005	4.1	5.1	2.5	0.20	6.37	4.17	4.01	Q ok
P34	MH13	MH14	1	0	1	0.00	0.95	0.00	0.11	6.0	6.37	3.94	0.4	15	44	0.012	0.0000	0.005	4.1	5.0	2.5	0.30	6.67	3.91	3.68	Q ok
P36	MH14	MH15	1	0	1	0.00	0.95	0.00	0.22	6.0	6.67	3.89	0.9	15	87	0.012	0.0001	0.005	4.1	5.0	2.9	0.51	7.17	3.57	3.12	Q ok
P-243	MH-15	MH-244	1	0	1	0.00	0.95	0.00	0.35	6.0	7.17	3.81	**1.35**	15	23	0.012	0.000372	0.0052	4.1	**5.1**	3.4	0.11	7.29	3.02	2.90	Q ok
P-244	MH-244	MH-245	1	0	1	0.00	0.95	0.00	1.85	6.0	7.29	3.79	**7.01**	24	79	0.012	0.000819	0.0089	7.3	**23.1**	6.2	0.21	7.50	2.80	2.10	Q ok
P-245	MH-245	MH-248	1	0	1	0.00	0.95	0.00	5.16	6.0	7.50	3.76	**19.39**	**36**	33	0.012	0.000720	0.0030	5.6	**39.8**	5.6	0.10	7.60	2.00	1.90	Q ok
P-248	MH-248	MH-252	1	0	1	0.00	0.95	0.00	5.53	6.0	7.60	3.74	**20.69**	**36**	115	0.012	0.000820	0.0033	5.9	**41.5**	5.8	0.33	7.93	1.80	1.42	Q ok
P-252	MH-252	MH-253	1	0	1	0.00	0.95	0.00	5.84	6.0	7.93	3.69	**21.55**	48	38	0.012	0.000192	0.0032	7.0	**87.4**	5.7	0.11	8.04	1.32	1.20	Q ok
P-253	MH-253	MH-254	1	0	1	0.00	0.95	0.00	5.84	6.0	8.04	3.68	**21.46**	48	102	0.012	0.000190	0.0031	6.9	**87.2**	5.7	0.30	8.34	1.10	0.78	Q ok
P-254	MH-254	OUTFALL	1	0	1	0.00	0.95	0.00	5.84	6.0	8.34	3.63	**21.16**	48	89	0.012	0.000185	0.0030	6.8	**85.7**	5.6	0.27	8.60	0.68	0.41	Q ok
P-240	DI-240	DI-241	4485	497	4982	0.11	0.87	0.10	0.10	6.0	0.00	4.01	**0.40**	15	30	0.012	0.000033	0.0050	4.0	**4.9**	2.4	0.21	6.21	3.72	3.57	Q ok
P-241	DI-241	DI-242	3403	140	3543	0.08	0.92	0.07	0.17	6.0	3.72	4.01	**0.70**	15	20	0.012	0.000100	0.0050	4.0	**4.9**	2.8	0.12	6.12	3.47	3.37	Q ok
P-242	DI-242	MH-244	6783	82	6865	0.16	0.94	0.15	0.32	6.0	3.47	4.01	**1.30**	15	12	0.012	0.000343	0.0050	4.0	**4.9**	3.3	0.06	6.06	3.27	3.21	Q ok
LIMIT FUTURE FLOW FROM A3 TO MACTH 36" PIPE CAPACITY TO MEET CLEARANCE/COVER REQUIREMENTS FOR P-245 & P-248. HOLE 48" OUTFALL																										
ASSUMED FUTURE FLOW ROUTED INTO NEW OUTFALL																										
Existing Offsite Area routed through Ex. 15" TC; Re-Routed to MH-244																										
P-Offsite	Exist Offsite	MH-244	52965	4000	56965	1.31	0.90	1.17	1.17	6.0	0.00	4.01	**4.70**	24	39	0.012	0.000368	0.0051	5.6	**17.6**	4.6	0.14	6.14	3.10	2.90	Q ok
Assumed 1/3 of Future Area 3 Routed to A St Future Trunk Line to P-261																										
P-Future A3	Addl A3	MH-261	**120000**	**0**	**120000**	2.75	0.95	2.62	2.62	6.0	0.00	4.01	**10.50**	30	98	0.012	0.000558	0.0096	8.9	**43.5**	7.3	0.22	6.22	4.20	3.26	Q ok
REMOVED 50,000SF OF A3 FROM ENTERING OUTFALL																										
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																										
P-260	DI-39	MH-261	4465	0	4465	0.10	0.95	0.10	0.10	6.0	0.00	4.01	**0.39**	15	44	0.012	0.000031	0.0032	3.2	**3.9**	1.9	0.38	6.38	3.40	3.26	Q ok
Exist Parcel Flow, Add Future A3 here																										
P-261	MH-261	MH-264	16653	1127	17780	0.41	0.90	0.37	3.08	6.0	6.38	3.94	**12.16**	36	145	0.012	0.000283	0.0030	5.6	**39.8**	4.8	0.50	6.88	3.16	2.72	Q ok
P-264	MH-264	MH-265	0	0	0	0.00	0.00	0.00	3.31	6.0	6.88	3.86	**12.77**	36	61	0.012	0.000312	0.0031	5.7	**40.3**	4.8	0.21	7.09	2.46	2.27	Q ok
P-265	MH-265	MH-245	0	0	0	0.00	0.00	0.00	3.31	6.0	7.09	3.83	**12.66**	36	*46*	0.012	0.000307	0.0037	6.2	**43.9**	5.3	0.15	7.24	2.17	2.00	Q ok
															STUB		22 LF	act length					act.	2.08		
P-262	DI-35&36	MH-264	5579	0	5579	0.13	0.95	0.12	0.12	6.0	0.00	4.01	**0.49**	15	36	0.012	0.000049	0.0031	3.2	**3.9**	2.2	0.27	6.27	3.38	3.27	Q ok
P-263	DI-37&38	MH-264	4770	0	4770	0.11	0.95	0.10	0.10	6.0	0.00	4.01	**0.42**	15	18	0.012	0.000036	0.0056	4.3	**5.2**	2.6	0.12	6.12	2.66	2.56	Q ok
Inlets Constructed in ASI																										
P-246	DI-6	MH-248	9946	0	9946	0.23	0.95	0.22	0.22	6.0	0.00	4.01	**0.87**	15	23	0.012	0.000155	0.0052	4.1	**5.1**	2.9	0.13	6.13	4.72	4.60	Q ok
P-247	DI-7	MH-248	7066	0	7066	0.16	0.95	0.15	0.15	6.0	0.00	4.01	**0.62**	15	26	0.012	0.000078	0.0046	3.9	**4.8**	2.7	0.16	6.16	4.74	4.62	Q ok
P-250	DI-8	MH-251	8718	0	8718	0.20	0.95	0.19	0.19	6.0	0.00	4.01	**0.76**	15	18	0.012	0.000119	0.0050	4.0	**4.9**	2.8	0.11	6.11	6.87	6.78	Q ok
P-251	MH-251	MH-252	0	0	0	0.00	0.00	0.00	0.31	6.0	6.12	4.00	**1.23**	15	54	0.012	0.000311	0.0078	5.0	**6.2**	3.8	0.24	6.36	6.68	6.26	Q ok
P-249	DI-9	MH-248	5442	0	5442	0.12	0.95	0.12	0.12	6.0	0.00	4.01	**0.48**	15	16	0.012	0.000046	0.0044	3.8	**4.6**	2.3	0.12	6.12	7.06	6.99	Q ok
P35	DI10	MH14	4962	681	5643	0.13	0.86	0.11	0.11	6.0	0.00	8.51	0.9	15	18	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.92	3.83	Q ok
P40	DI12	DI11	2375	125	2500	0.06	0.91	0.05	0.05	6.0	0.00	8.51	0.4	15	39	0.012	0.0000	0.005	4.0	4.9	2.4	0.27	6.27	3.67	3.47	Q ok
P37	DI11	MH15	3715	653	4368	0.10	0.83	0.08	0.14	6.0	6.27	8.40	1.1	15	18	0.012	0.0003	0.005	4.0	4.9	3.3	0.09	6.36	3.33	3.24	Q ok
FUTURE PIPES FOR AREA 3, NOT INCLUDED IN AREA 1 SUBMITTAL																										

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	4.81	5.01	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.01	8.36	HGL ok
P34	MH13	MH14	1.00	4.80	4.80	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	4.81	8.11	HGL ok
P36	MH14	MH15	1.00	4.79	4.79	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	4.80	7.86	HGL ok
P-243	MH-15	MH-244	1.00	4.77	4.77	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	4.79	7.17	HGL ok
P-244	MH-244	MH-245	1.60	4.68	4.68	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	4.77	7.35	HGL ok
P-245	MH-245	MH-248	2.40	4.61	4.61	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	4.68	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.48	4.48	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	4.61	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.03	4.40	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	4.48	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.66	3.98	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	4.03	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.20**	**3.61**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**3.66**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	4.79	4.79	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.80	6.85	HGL ok
P-241	DI-241	DI-242	1.00	4.79	4.79	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	4.79	6.98	HGL ok
P-242	DI-242	MH-244	1.00	4.77	4.77	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	4.79	7.07	HGL ok
P-Offsite	Exist Offsite	MH-244	1.60	4.77	4.77	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	4.79	7.07	HGL ok
P-Future A3	Addl A3	MH-261	2.00	5.17	5.26	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	5.33	7.20	HGL ok
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	5.17	5.17	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.17	6.78	HGL ok
P-261	MH-261	MH-264	2.40	4.74	5.12	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	5.17	6.80	HGL ok
P-264	MH-264	MH-265	2.40	4.71	4.71	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	4.74	6.48	HGL ok
P-265	MH-265	MH-245	2.40	4.68	4.68	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	4.71	6.82	HGL ok
P-262	DI-35&36	MH-264	1.00	4.74	4.74	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.74	7.04	HGL ok
P-263	DI-37&38	MH-264	1.00	4.74	4.74	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.74	6.35	HGL ok
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	4.61	5.60	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.61	8.38	HGL ok
P-247	DI-7	MH-248	1.00	4.61	5.62	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.62	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.29	7.78	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.78	10.19	HGL ok
P-251	MH-251	MH-252	1.00	4.80	7.26	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	7.29	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.29	7.99	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	4.80	4.83	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	4.84	8.11	HGL ok
P40	DI12	DI11	1.00	4.80	4.80	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.80	7.19	HGL ok
P37	DI11	MH15	1.00	4.79	4.79	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	4.80	7.09	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	4.81	5.01	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.01	8.36	HGL ok
P34	MH13	MH14	1.00	4.80	4.80	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	4.81	8.11	HGL ok
P36	MH14	MH15	1.00	4.79	4.79	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	4.80	7.86	HGL ok
P-243	MH-15	MH-244	1.00	4.77	4.77	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	4.79	7.17	HGL ok
P-244	MH-244	MH-245	1.60	4.68	4.68	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	4.77	7.35	HGL ok
P-245	MH-245	MH-248	2.40	4.61	4.61	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	4.68	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.48	4.48	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	4.61	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.03	4.40	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	4.48	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.66	3.98	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	4.03	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.40**	**3.61**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**3.66**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	4.79	4.79	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.80	6.85	HGL ok
P-241	DI-241	DI-242	1.00	4.79	4.79	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	4.79	6.98	HGL ok
P-242	DI-242	MH-244	1.00	4.77	4.77	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	4.79	7.07	HGL ok
P-Offsite	Exist Offsite	MH-244	1.60	4.77	4.77	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	4.79	7.07	HGL ok
P-Future A3	Addl A3	MH-261	2.00	5.17	5.26	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	5.33	7.20	HGL ok
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	5.17	5.17	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.17	6.78	HGL ok
P-261	MH-261	MH-264	2.40	4.74	5.12	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	5.17	6.80	HGL ok
P-264	MH-264	MH-265	2.40	4.71	4.71	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	4.74	6.48	HGL ok
P-265	MH-265	MH-245	2.40	4.68	4.68	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	4.71	6.82	HGL ok
P-262	DI-35&36	MH-264	1.00	4.74	4.74	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.74	7.04	HGL ok
P-263	DI-37&38	MH-264	1.00	4.74	4.74	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.74	6.35	HGL ok
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	4.61	5.60	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.61	8.38	HGL ok
P-247	DI-7	MH-248	1.00	4.61	5.62	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.62	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.29	7.78	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.78	10.19	HGL ok
P-251	MH-251	MH-252	1.00	4.80	7.26	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	7.29	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.29	7.99	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	4.80	4.83	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	4.84	8.11	HGL ok
P40	DI12	DI11	1.00	4.80	4.80	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.80	7.19	HGL ok
P37	DI11	MH15	1.00	4.79	4.79	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	4.80	7.09	HGL ok

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	7.40	7.40	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.40	8.36	HGL Too High!
P34	MH13	MH14	1.00	7.40	7.40	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	7.40	8.11	HGL Too High!
P36	MH14	MH15	1.00	7.38	7.38	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	7.40	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	7.36	7.36	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	7.38	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.27	7.27	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	7.36	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.21	7.21	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	7.27	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.07	7.07	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	7.21	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.99	6.99	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	7.07	9.40	HGL ok
P-253	MH-253	MH-254	3.20	6.95	6.95	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	6.99	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**6.95**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	7.39	7.39	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.39	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	7.38	7.38	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	7.39	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	7.36	7.36	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	7.38	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	7.36	7.36	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.39	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	7.38	7.38	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	7.45	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	7.38	7.38	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.38	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	7.33	7.33	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	7.38	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.30	7.30	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	7.33	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.27	7.27	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	7.30	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	7.33	7.33	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.34	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	7.33	7.33	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.33	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.21	7.21	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.21	8.38	HGL ok
P-247	DI-7	MH-248	1.00	7.21	7.21	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.21	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.41	7.78	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.78	10.19	HGL ok
P-251	MH-251	MH-252	1.00	7.39	7.39	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	7.41	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.41	7.99	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	7.40	7.40	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.40	8.11	HGL Too High!
P40	DI12	DI11	1.00	7.39	7.39	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.39	7.19	HGL Too High!
P37	DI11	MH15	1.00	7.38	7.38	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	7.39	7.09	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	7.90	7.90	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.90	8.36	HGL Too High!
P34	MH13	MH14	1.00	7.90	7.90	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	7.90	8.11	HGL Too High!
P36	MH14	MH15	1.00	7.88	7.88	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	7.90	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	7.86	7.86	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	7.88	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.77	7.77	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	7.86	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.71	7.71	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	7.77	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.57	7.57	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	7.71	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.49	7.49	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	7.57	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.45	7.45	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	7.49	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**7.45**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	7.89	7.89	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.89	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	7.88	7.88	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	7.89	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	7.86	7.86	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	7.88	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	7.86	7.86	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.89	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	7.88	7.88	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	7.95	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	7.88	7.88	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.88	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	7.83	7.83	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	7.88	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.80	7.80	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	7.83	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.77	7.77	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	7.80	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	7.83	7.83	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.84	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	7.83	7.83	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.83	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.71	7.71	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.71	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	7.71	7.71	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.71	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	7.91	7.91	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.92	10.19	HGL ok
P-251	MH-251	MH-252	1.00	7.89	7.89	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	7.91	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.91	7.99	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	7.90	7.90	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.90	8.11	HGL Too High!
P40	DI12	DI11	1.00	7.89	7.89	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.89	7.19	HGL Too High!
P37	DI11	MH15	1.00	7.88	7.88	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	7.89	7.09	HGL Too High!

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RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.30	8.30	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.30	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.30	8.30	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	8.30	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.28	8.28	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	8.30	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.26	8.26	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	8.28	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.17	8.17	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	8.26	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.11	8.11	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	8.17	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.97	7.97	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	8.11	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.89	7.89	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	7.97	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.85	7.85	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	7.89	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**7.85**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	8.29	8.29	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.29	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.28	8.28	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	8.29	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.26	8.26	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	8.28	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.26	8.26	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.29	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.28	8.28	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	8.35	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.28	8.28	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.28	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.23	8.23	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	8.28	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.20	8.20	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	8.23	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.17	8.17	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	8.20	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.23	8.23	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.24	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.23	8.23	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.23	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.11	8.11	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.11	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.11	8.11	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.11	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	8.31	8.31	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.32	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.29	8.29	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	8.31	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.31	8.31	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.32	10.89	HGL ok
P35	DI10	MH14	1.00	8.30	8.30	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.30	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.29	8.29	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.29	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.28	8.28	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	8.29	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.80	8.80	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.80	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.80	8.80	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	8.80	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.78	8.78	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	8.80	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.76	8.76	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	8.78	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.67	8.67	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	8.76	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.61	8.61	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	8.67	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.47	8.47	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	8.61	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.39	8.39	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	8.47	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	8.35	8.35	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	8.39	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**8.35**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	8.79	8.79	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.79	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.78	8.78	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	8.79	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.76	8.76	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	8.78	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.76	8.76	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.79	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.78	8.78	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	8.85	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.78	8.78	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.78	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.73	8.73	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	8.78	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.70	8.70	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	8.73	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.67	8.67	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	8.70	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.73	8.73	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.74	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.73	8.73	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.73	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.61	8.61	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.61	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.61	8.61	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.61	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	8.81	8.81	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.82	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.79	8.79	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	8.81	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.81	8.81	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.82	10.89	HGL ok
P35	DI10	MH14	1.00	8.80	8.80	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.80	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.79	8.79	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.79	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.78	8.78	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	8.79	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.50	9.50	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.50	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.50	9.50	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	9.50	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.48	9.48	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	9.50	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.46	9.46	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	9.48	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.37	9.37	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	9.46	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.31	9.31	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	9.37	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.17	9.17	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	9.31	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.09	9.09	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	9.17	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.05	9.05	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	9.09	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**9.05**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	9.49	9.49	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.49	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.48	9.48	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	9.49	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.46	9.46	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	9.48	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.46	9.46	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.49	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.48	9.48	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	9.55	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.48	9.48	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.48	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.43	9.43	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	9.48	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.40	9.40	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	9.43	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.37	9.37	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	9.40	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.43	9.43	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.44	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.43	9.43	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.43	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.31	9.31	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.31	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.31	9.31	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.31	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.51	9.51	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.52	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.49	9.49	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	9.51	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.51	9.51	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.52	10.89	HGL ok
P35	DI10	MH14	1.00	9.50	9.50	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.50	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.49	9.49	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.49	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.48	9.48	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	9.49	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ftnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.00	10.00	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.00	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.00	10.00	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	10.00	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.98	9.98	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	10.00	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.96	9.96	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	9.98	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.87	9.87	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	9.96	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.81	9.81	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	9.87	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.67	9.67	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	9.81	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.59	9.59	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	9.67	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.55	9.55	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	9.59	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**9.55**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	9.99	9.99	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.99	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.98	9.98	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	9.99	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.96	9.96	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	9.98	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.96	9.96	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.99	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.98	9.98	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	10.05	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																															
P-260	DI-39	MH-261	1.00	9.98	9.98	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.98	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.93	9.93	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	9.98	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.90	9.90	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	9.93	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.87	9.87	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	9.90	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.93	9.93	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.94	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.93	9.93	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.93	6.35	HGL Too High!
Inlets Constructed in ASI																															
P-246	DI-6	MH-248	1.00	9.81	9.81	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.81	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.81	9.81	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.81	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.01	10.01	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.02	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.99	9.99	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	10.01	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.01	10.01	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.02	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.00	10.00	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.00	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.99	9.99	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.99	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.98	9.98	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	9.99	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.30	11.30	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.30	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.30	11.30	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	11.30	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.28	11.28	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	11.30	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.26	11.26	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	11.28	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.17	11.17	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	11.26	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.11	11.11	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	11.17	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.97	10.97	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	11.11	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.89	10.89	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	10.97	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.85	10.85	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	10.89	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**10.85**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.29	11.29	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.29	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.28	11.28	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	11.29	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.26	11.26	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	11.28	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.26	11.26	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.29	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.28	11.28	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	11.35	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.28	11.28	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.28	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.23	11.23	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	11.28	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.20	11.20	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	11.23	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.17	11.17	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	11.20	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.23	11.23	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.24	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.23	11.23	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.23	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.11	11.11	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.11	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.11	11.11	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.11	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.31	11.31	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.32	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.29	11.29	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	11.31	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.31	11.31	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.32	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.30	11.30	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.30	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.29	11.29	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.29	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.28	11.28	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.29	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.24	6.24	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.24	8.36	HGL ok
P34	MH13	MH14	1.00	6.24	6.24	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	6.24	8.11	HGL ok
P36	MH14	MH15	1.00	6.22	6.22	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	6.24	7.86	HGL ok
P-243	MH-15	MH-244	1.00	6.20	6.20	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	6.22	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	6.11	6.11	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	6.20	7.35	HGL ok
P-245	MH-245	MH-248	2.40	6.05	6.05	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	6.11	7.93	HGL ok
P-248	MH-248	MH-252	2.40	5.91	5.91	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	6.05	7.35	HGL ok
P-252	MH-252	MH-253	3.20	5.83	5.83	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	5.91	9.40	HGL ok
P-253	MH-253	MH-254	3.20	5.79	5.79	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	5.83	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**5.79**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	6.23	6.23	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.23	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	6.22	6.22	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	6.23	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	6.20	6.20	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	6.22	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	6.20	6.20	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	6.23	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	6.22	6.22	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	6.29	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	6.22	6.22	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.22	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	6.17	6.17	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	6.22	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	6.14	6.14	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	6.17	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	6.11	6.11	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	6.14	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	6.17	6.17	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.18	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	6.17	6.17	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.17	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	6.05	6.05	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.05	8.38	HGL ok
P-247	DI-7	MH-248	1.00	6.05	6.05	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.05	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.29	7.78	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.78	10.19	HGL ok
P-251	MH-251	MH-252	1.00	6.23	7.26	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	7.29	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.29	7.99	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	6.24	6.24	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.24	8.11	HGL ok
P40	DI12	DI11	1.00	6.23	6.23	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.23	7.19	HGL Too High!
P37	DI11	MH15	1.00	6.22	6.22	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	6.23	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.44	6.44	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.44	8.36	HGL ok
P34	MH13	MH14	1.00	6.44	6.44	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	6.44	8.11	HGL ok
P36	MH14	MH15	1.00	6.42	6.42	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	6.44	7.86	HGL ok
P-243	MH-15	MH-244	1.00	6.40	6.40	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	6.42	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	6.31	6.31	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	6.40	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	6.25	6.25	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	6.31	7.93	HGL ok
P-248	MH-248	MH-252	2.40	6.11	6.11	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	6.25	7.35	HGL ok
P-252	MH-252	MH-253	3.20	6.03	6.03	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	6.11	9.40	HGL ok
P-253	MH-253	MH-254	3.20	5.99	5.99	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	6.03	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**5.99**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	6.43	6.43	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.43	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	6.42	6.42	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	6.43	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	6.40	6.40	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	6.42	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	6.40	6.40	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	6.43	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	6.42	6.42	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	6.49	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	6.42	6.42	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.42	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	6.37	6.37	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	6.42	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	6.34	6.34	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	6.37	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	6.31	6.31	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	6.34	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	6.37	6.37	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.38	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	6.37	6.37	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.37	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	6.25	6.25	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.25	8.38	HGL ok
P-247	DI-7	MH-248	1.00	6.25	6.25	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.25	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.29	7.78	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.78	10.19	HGL ok
P-251	MH-251	MH-252	1.00	6.43	7.26	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	7.29	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.29	7.99	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	6.44	6.44	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.44	8.11	HGL ok
P40	DI12	DI11	1.00	6.43	6.43	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.43	7.19	HGL Too High!
P37	DI11	MH15	1.00	6.42	6.42	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	6.43	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.94	9.94	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.94	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.94	9.94	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	9.94	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.92	9.92	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	9.94	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.90	9.90	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	9.92	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.81	9.81	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	9.90	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.75	9.75	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	9.81	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.61	9.61	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	9.75	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.53	9.53	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	9.61	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.49	9.49	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	9.53	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**9.49**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	9.93	9.93	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.93	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.92	9.92	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	9.93	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.90	9.90	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	9.92	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.90	9.90	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.93	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.92	9.92	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	9.99	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.92	9.92	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.92	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.87	9.87	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	9.92	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.84	9.84	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	9.87	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.81	9.81	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	9.84	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.87	9.87	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.88	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.87	9.87	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.87	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.75	9.75	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.75	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.75	9.75	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.75	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.95	9.95	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.96	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.93	9.93	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	9.95	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.95	9.95	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.96	10.89	HGL Too High!
P35	DI10	MH14	1.00	9.94	9.94	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.94	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.93	9.93	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.93	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.92	9.92	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	9.93	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.44	10.44	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.44	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.44	10.44	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	10.44	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.42	10.42	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	10.44	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.40	10.40	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	10.42	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.31	10.31	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	10.40	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.25	10.25	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	10.31	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.11	10.11	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	10.25	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.03	10.03	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	10.11	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.99	9.99	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	10.03	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**9.99**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.43	10.43	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.43	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.42	10.42	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	10.43	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.40	10.40	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	10.42	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.40	10.40	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.43	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.42	10.42	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	10.49	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.42	10.42	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.42	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.37	10.37	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	10.42	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.34	10.34	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	10.37	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.31	10.31	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	10.34	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.37	10.37	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.38	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.37	10.37	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.37	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.25	10.25	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.25	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.25	10.25	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.25	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.45	10.45	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.46	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.43	10.43	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	10.45	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.45	10.45	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.46	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.44	10.44	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.44	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.43	10.43	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.43	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.42	10.42	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	10.43	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.84	10.84	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.84	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.84	10.84	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	10.84	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.82	10.82	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	10.84	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.80	10.80	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	10.82	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.71	10.71	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	10.80	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.65	10.65	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	10.71	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.51	10.51	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	10.65	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.43	10.43	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	10.51	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.39	10.39	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	10.43	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**10.39**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.83	10.83	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.83	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.82	10.82	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	10.83	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.80	10.80	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	10.82	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.80	10.80	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.83	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.82	10.82	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	10.89	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.82	10.82	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.82	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.77	10.77	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	10.82	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.74	10.74	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	10.77	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.71	10.71	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	10.74	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.77	10.77	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.78	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.77	10.77	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.77	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.65	10.65	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.65	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.65	10.65	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.65	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.85	10.85	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.86	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.83	10.83	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	10.85	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.85	10.85	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.86	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.84	10.84	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.84	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.83	10.83	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.83	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.82	10.82	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	10.83	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.34	11.34	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.34	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.34	11.34	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	11.34	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.32	11.32	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	11.34	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.30	11.30	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	11.32	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.21	11.21	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	11.30	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.15	11.15	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	11.21	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.01	11.01	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	11.15	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.93	10.93	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	11.01	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.89	10.89	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	10.93	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**10.89**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.33	11.33	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.33	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.32	11.32	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	11.33	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.30	11.30	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	11.32	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.30	11.30	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.33	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.32	11.32	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	11.39	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.32	11.32	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.32	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.27	11.27	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	11.32	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.24	11.24	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	11.27	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.21	11.21	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	11.24	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.27	11.27	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.28	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.27	11.27	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.27	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.15	11.15	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.15	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.15	11.15	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.15	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.35	11.35	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.36	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.33	11.33	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	11.35	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.35	11.35	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.36	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.34	11.34	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.34	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.33	11.33	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.33	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.32	11.32	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.33	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ftnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.04	12.04	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.04	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.04	12.04	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	12.04	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.02	12.02	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	12.04	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.00	12.00	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	12.02	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.91	11.91	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	12.00	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.85	11.85	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	11.91	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.71	11.71	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	11.85	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.63	11.63	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	11.71	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.59	11.59	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	11.63	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**11.59**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.03	12.03	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.03	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.02	12.02	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	12.03	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.00	12.00	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	12.02	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.00	12.00	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.03	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.02	12.02	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	12.09	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.02	12.02	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.02	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.97	11.97	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	12.02	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.94	11.94	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	11.97	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.91	11.91	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	11.94	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.97	11.97	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.98	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.97	11.97	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.97	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.85	11.85	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.85	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.85	11.85	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.85	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.05	12.05	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.06	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.03	12.03	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	12.05	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.05	12.05	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.06	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.04	12.04	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.04	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.03	12.03	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.03	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.02	12.02	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	12.03	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.54	12.54	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.54	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.54	12.54	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	12.54	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.52	12.52	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	12.54	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.50	12.50	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	12.52	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.41	12.41	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	12.50	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.35	12.35	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	12.41	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.21	12.21	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	12.35	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	12.13	12.13	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	12.21	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	12.09	12.09	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	12.13	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**12.09**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.53	12.53	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.53	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.52	12.52	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	12.53	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.50	12.50	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	12.52	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.50	12.50	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.53	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.52	12.52	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	12.59	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.52	12.52	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.52	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.47	12.47	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	12.52	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.44	12.44	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	12.47	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.41	12.41	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	12.44	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.47	12.47	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.48	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.47	12.47	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.47	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.35	12.35	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.35	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.35	12.35	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.35	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.55	12.55	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.56	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.53	12.53	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	12.55	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.55	12.55	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.56	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.54	12.54	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.54	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.53	12.53	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.53	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.52	12.52	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	12.53	7.09	HGL Too High!

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Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.84	13.84	15	0.4	0.3	90	30.4	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.84	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.84	13.84	15	0.4	0.3	0	44.2	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	13.84	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.82	13.82	15	0.9	0.7	0	87.2	0.0001	0.01	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	0	0.00	0.00	1.3	0.5	0.00	0.01	13.84	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.80	13.80	15	1.4	1.1	12.7	23	0.0004	0.01	0	0.00	0.00	0.6	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	13.82	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	13.71	13.71	24	7.0	2.2	45	79	0.0008	0.06	0	0.00	0.02	1.5	1.4	7.0	1.5	0.0	90	0.02	0.06	1.0	0.5	0.03	0.09	13.80	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	13.65	13.65	36	19.4	2.7	0	33	0.0007	0.02	1	0.00	0.03	15.7	22.7	0.0	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.06	13.71	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	13.51	13.51	36	20.7	2.9	90	115	0.0008	0.09	2	0.00	0.03	53.2	0.6	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.04	0.13	13.65	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	13.43	13.43	48	21.6	1.7	90	38	0.0002	0.01	0	0.00	0.01	60.6	1.2	0.0	2.9	0.0	90	0.09	0.15	1.0	0.5	0.08	0.08	13.51	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	13.39	13.39	48	21.5	1.7	16.6	102	0.0002	0.02	0	0.00	0.01	53.2	0.0	0.0	2.7	0.0	0	0.00	0.05	1.0	0.5	0.03	0.05	13.43	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**21.2**	**1.7**	**0**	**89**	**0.0002**	**0.02**	**0**	**0.00**	**0.01**	**37.0**	**0.0**	**0.0**	**1.7**	**0.0**	**90**	**0.03**	**0.06**	**1.0**	**0.5**	**0.03**	**0.05**	**13.39**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.83	13.83	15	0.4	0.3	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.83	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.82	13.82	15	0.7	0.6	90	20	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	1.0	0.00	0.01	13.83	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.80	13.80	15	1.3	1.1	90	12	0.0003	0.00	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	13.82	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.80	13.80	24	4.7	1.5	90	39	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.83	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.82	13.82	30	10.5	2.1	90	98	0.0006	0.05	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.07	13.89	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.82	13.82	15	0.4	0.3	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.82	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.77	13.77	36	12.2	1.7	0	145	0.0003	0.04	0	0.00	0.01	0.1	0.0	0.0	0.3	0.0	90	0.00	0.01	1.3	0.5	0.01	0.05	13.82	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	13.74	13.74	36	12.8	1.8	0	61	0.0003	0.02	0	0.00	0.01	20.9	0.2	0.1	1.7	0.0	0	0.00	0.03	1.0	0.5	0.01	0.03	13.77	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	13.71	13.71	36	12.7	1.8	90	46	0.0003	0.01	0	0.00	0.01	23.1	0.0	0.0	1.8	0.0	0	0.00	0.03	1.0	0.5	0.02	0.03	13.74	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.77	13.77	15	0.5	0.4	90	36	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.78	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.77	13.77	15	0.4	0.3	90	18	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.77	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	13.65	13.65	15	0.9	0.7	90	23	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.65	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	13.65	13.65	15	0.6	0.5	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.65	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.85	13.85	15	0.8	0.6	85.5	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.86	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.83	13.83	15	1.2	1.0	91.5	54	0.0003	0.02	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	85.5	0.00	0.01	1.0	1.0	0.01	0.03	13.85	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.85	13.85	15	0.5	0.4	93.9	16	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.86	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.84	13.84	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.84	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.83	13.83	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.83	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.82	13.82	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	13.83	7.09	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 5 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: Market Street Outfall (North) | Storm Frequency: 2 -year (50-year for sumps)
4

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P33	DI24	MH13	4615	1621	6236	0.14	0.75	0.11	0.11	6.0	6.17	4.73	0.5	15	30	0.012	0.0001	0.005	4.1	5.1	2.5	0.20	6.37	4.17	4.01	Q ok
P34	MH13	MH14	1	0	1	0.00	0.95	0.00	0.11	6.0	6.37	4.69	0.5	15	44	0.012	0.0001	0.005	4.1	5.0	2.5	0.30	6.67	3.91	3.68	Q ok
P36	MH14	MH15	1	0	1	0.00	0.95	0.00	0.22	6.0	6.67	4.63	1.0	15	87	0.012	0.0002	0.005	4.1	5.0	3.1	0.47	7.14	3.57	3.12	Q ok
P-243	MH-15	MH-244	1	0	1	0.00	0.95	0.00	0.35	6.0	7.14	4.55	**1.61**	15	23	0.012	0.000531	0.0052	4.1	**5.1**	3.5	0.11	7.25	3.02	2.90	Q ok
P-244	MH-244	MH-245	1	0	1	0.00	0.95	0.00	1.85	6.0	7.25	4.51	**8.34**	24	79	0.012	0.001158	0.0089	7.3	**23.1**	6.6	0.20	7.45	2.80	2.10	Q ok
P-245	MH-245	MH-248	1	0	1	0.00	0.95	0.00	5.16	6.0	7.45	4.49	**23.16**	**36**	33	0.012	0.001027	0.0030	5.6	**39.8**	5.9	0.09	7.54	2.00	1.90	Q ok
P-248	MH-248	MH-252	1	0	1	0.00	0.95	0.00	5.53	6.0	7.54	4.47	**24.71**	**36**	115	0.012	0.001170	0.0033	5.9	**41.5**	6.2	0.31	7.85	1.80	1.42	Q ok
P-252	MH-252	MH-253	1	0	1	0.00	0.95	0.00	5.84	6.0	7.85	4.39	**25.62**	48	38	0.012	0.000271	0.0032	7.0	**87.4**	5.9	0.11	7.96	1.32	1.20	Q ok
P-253	MH-253	MH-254	1	0	1	0.00	0.95	0.00	5.84	6.0	7.96	4.37	**25.51**	48	102	0.012	0.000269	0.0031	6.9	**87.2**	5.9	0.29	8.25	1.10	0.78	Q ok
P-254	MH-254	OUTFALL	1	0	1	0.00	0.95	0.00	5.84	6.0	8.25	4.33	**25.27**	48	89	0.012	0.000264	0.0030	6.8	**85.7**	5.8	0.26	8.50	0.68	0.41	Q ok
P-240	DI-240	DI-241	4485	497	4982	0.11	0.87	0.10	0.10	6.0	0.00	4.77	**0.48**	15	30	0.012	0.000046	0.0050	4.0	**4.9**	2.4	0.21	6.21	3.72	3.57	Q ok
P-241	DI-241	DI-242	3403	140	3543	0.08	0.92	0.07	0.17	6.0	3.72	4.77	**0.83**	15	20	0.012	0.000142	0.0050	4.0	**4.9**	2.8	0.12	6.12	3.47	3.37	Q ok
P-242	DI-242	MH-244	6783	82	6865	0.16	0.94	0.15	0.32	6.0	3.47	4.77	**1.54**	15	12	0.012	0.000485	0.0050	4.0	**4.9**	3.4	0.06	6.06	3.27	3.21	Q ok
LIMIT FUTURE FLOW FROM A3 TO MACTH 36" PIPE CAPACITY TO MEET CLEARANCE/COVER REQUIREMENTS FOR P-245 & P-248. HOLE 48" OUTFALL																										
ASSUMED FUTURE FLOW ROUTED INTO NEW OUTFALL																										
Existing Offsite Area routed through Ex. 15" TC; Re-Routed to MH-244																										
P-Offsite	Exist Offsite	MH-244	52965	4000	56965	1.31	0.90	1.17	1.17	6.0	0.00	4.77	**5.59**	24	39	0.012	0.000520	0.0051	5.6	**17.6**	4.7	0.14	6.14	3.10	2.90	Q ok
Assumed 1/3 of Future Area 3 Routed to A St Future Trunk Line to P-261																										
P-Future A3	Addl A3	MH-261	**120000**	**0**	**120000**	2.75	0.95	2.62	2.62	6.0	0.00	4.77	**12.48**	30	98	0.012	0.000789	0.0096	8.9	**43.5**	7.5	0.22	6.22	4.20	3.26	Q ok
REMOVED 50,000SF OF A3 FROM ENTERING OUTFALL																										
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																										
P-260	DI-39	MH-261	4465	0	4465	0.10	0.95	0.10	0.10	6.0	0.00	4.77	**0.46**	15	44	0.012	0.000044	0.0032	3.2	**3.9**	1.9	0.38	6.38	3.40	3.26	Q ok
Exist Parcel Flow, Add Future A3 here																										
P-261	MH-261	MH-264	16653	1127	17780	0.41	0.90	0.37	3.08	6.0	6.38	4.69	**14.46**	36	145	0.012	0.000400	0.0030	5.6	**39.8**	5.1	0.48	6.86	3.16	2.72	Q ok
P-264	MH-264	MH-265	0	0	0	0.00	0.00	0.00	3.31	6.0	6.86	4.59	**15.18**	36	61	0.012	0.000442	0.0031	5.7	**40.3**	5.2	0.19	7.05	2.46	2.27	Q ok
P-265	MH-265	MH-245	0	0	0	0.00	0.00	0.00	3.31	6.0	7.05	4.55	**15.05**	36	*46*	0.012	0.000434	0.0037	6.2	**43.9**	5.6	0.14	7.19	2.17	2.00	Q ok
															STUB		22 LF	act length					act.	2.08		
P-262	DI-35&36	MH-264	5579	0	5579	0.13	0.95	0.12	0.12	6.0	0.00	4.77	**0.58**	15	36	0.012	0.000069	0.0031	3.2	**3.9**	2.2	0.27	6.27	3.38	3.27	Q ok
P-263	DI-37&38	MH-264	4770	0	4770	0.11	0.95	0.10	0.10	6.0	0.00	4.77	**0.50**	15	18	0.012	0.000050	0.0056	4.3	**5.2**	2.6	0.12	6.12	2.66	2.56	Q ok
Inlets Constructed in ASI																										
P-246	DI-6	MH-248	9946	0	9946	0.23	0.95	0.22	0.22	6.0	0.00	4.77	**1.03**	15	23	0.012	0.000219	0.0052	4.1	**5.1**	3.1	0.12	6.12	4.72	4.60	Q ok
P-247	DI-7	MH-248	7066	0	7066	0.16	0.95	0.15	0.15	6.0	0.00	4.77	**0.74**	15	26	0.012	0.000110	0.0046	3.9	**4.8**	2.7	0.16	6.16	4.74	4.62	Q ok
P-250	DI-8	MH-251	8718	0	8718	0.20	0.95	0.19	0.19	6.0	0.00	4.77	**0.91**	15	18	0.012	0.000168	0.0050	4.0	**4.9**	3.0	0.10	6.10	6.87	6.78	Q ok
P-251	MH-251	MH-252	0	0	0	0.00	0.00	0.00	0.31	6.0	6.12	4.75	**1.47**	15	54	0.012	0.000439	0.0078	5.0	**6.2**	4.1	0.22	6.34	6.68	6.26	Q ok
P-249	DI-9	MH-248	5442	0	5442	0.12	0.95	0.12	0.12	6.0	0.00	4.77	**0.57**	15	16	0.012	0.000065	0.0044	3.8	**4.6**	2.3	0.12	6.12	7.06	6.99	Q ok
P35	DI10	MH14	4962	681	5643	0.13	0.86	0.11	0.11	6.0	0.00	8.51	0.9	15	18	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.92	3.83	Q ok
P40	DI12	DI11	2375	125	2500	0.06	0.91	0.05	0.05	6.0	0.00	8.51	0.4	15	39	0.012	0.0000	0.005	4.0	4.9	2.4	0.27	6.27	3.67	3.47	Q ok
P37	DI11	MH15	3715	653	4368	0.10	0.83	0.08	0.14	6.0	6.27	8.40	1.1	15	18	0.012	0.0003	0.005	4.0	4.9	3.3	0.09	6.36	3.33	3.24	Q ok
	FUTURE PIPES FOR AREA 3, NOT INCLUDED IN AREA 1 SUBMITTAL																									

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	4.98	5.01	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.01	8.36	HGL ok
P34	MH13	MH14	1.00	4.97	4.97	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	4.98	8.11	HGL ok
P36	MH14	MH15	1.00	4.95	4.95	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	4.97	7.86	HGL ok
P-243	MH-15	MH-244	1.00	4.93	4.93	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	4.95	7.17	HGL ok
P-244	MH-244	MH-245	1.60	4.80	4.80	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	4.93	7.35	HGL ok
P-245	MH-245	MH-248	2.40	4.71	4.71	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	4.80	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.52	4.52	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	4.71	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.04	4.40	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	4.52	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.68	3.98	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	4.04	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.20**	**3.61**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**3.68**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	4.96	4.96	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.96	6.85	HGL ok
P-241	DI-241	DI-242	1.00	4.95	4.95	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	4.96	6.98	HGL ok
P-242	DI-242	MH-244	1.00	4.93	4.93	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	4.95	7.07	HGL ok
P-Offsite	Exist Offsite	MH-244	1.60	4.93	4.93	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	4.96	7.07	HGL ok
P-Future A3	Addl A3	MH-261	2.00	5.19	5.26	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	5.36	7.20	HGL ok
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	5.19	5.19	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.19	6.78	HGL ok
P-261	MH-261	MH-264	2.40	4.89	5.12	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	5.19	6.80	HGL ok
P-264	MH-264	MH-265	2.40	4.84	4.84	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	4.89	6.48	HGL ok
P-265	MH-265	MH-245	2.40	4.80	4.80	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	4.84	6.82	HGL ok
P-262	DI-35&36	MH-264	1.00	4.89	4.89	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.04	HGL ok
P-263	DI-37&38	MH-264	1.00	4.89	4.89	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	6.35	HGL ok
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	4.71	5.60	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.61	8.38	HGL ok
P-247	DI-7	MH-248	1.00	4.71	5.62	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.62	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.30	7.78	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	4.96	7.26	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	7.30	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.30	7.99	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	4.97	4.97	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	4.98	8.11	HGL ok
P40	DI12	DI11	1.00	4.96	4.96	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.96	7.19	HGL ok
P37	DI11	MH15	1.00	4.95	4.95	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	4.96	7.09	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	4.98	5.01	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.01	8.36	HGL ok
P34	MH13	MH14	1.00	4.97	4.97	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	4.98	8.11	HGL ok
P36	MH14	MH15	1.00	4.95	4.95	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	4.97	7.86	HGL ok
P-243	MH-15	MH-244	1.00	4.93	4.93	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	4.95	7.17	HGL ok
P-244	MH-244	MH-245	1.60	4.80	4.80	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	4.93	7.35	HGL ok
P-245	MH-245	MH-248	2.40	4.71	4.71	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	4.80	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.52	4.52	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	4.71	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.04	4.40	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	4.52	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.68	3.98	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	4.04	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.40**	**3.61**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**3.68**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	4.96	4.96	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.96	6.85	HGL ok
P-241	DI-241	DI-242	1.00	4.95	4.95	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	4.96	6.98	HGL ok
P-242	DI-242	MH-244	1.00	4.93	4.93	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	4.95	7.07	HGL ok
P-Offsite	Exist Offsite	MH-244	1.60	4.93	4.93	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	4.96	7.07	HGL ok
P-Future A3	Addl A3	MH-261	2.00	5.19	5.26	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	5.36	7.20	HGL ok
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	5.19	5.19	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.19	6.78	HGL ok
P-261	MH-261	MH-264	2.40	4.89	5.12	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	5.19	6.80	HGL ok
P-264	MH-264	MH-265	2.40	4.84	4.84	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	4.89	6.48	HGL ok
P-265	MH-265	MH-245	2.40	4.80	4.80	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	4.84	6.82	HGL ok
P-262	DI-35&36	MH-264	1.00	4.89	4.89	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	7.04	HGL ok
P-263	DI-37&38	MH-264	1.00	4.89	4.89	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.89	6.35	HGL ok
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	4.71	5.60	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.61	8.38	HGL ok
P-247	DI-7	MH-248	1.00	4.71	5.62	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.62	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.30	7.78	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	4.96	7.26	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	7.30	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.30	7.99	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	4.97	4.97	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	4.98	8.11	HGL ok
P40	DI12	DI11	1.00	4.96	4.96	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	4.96	7.19	HGL ok
P37	DI11	MH15	1.00	4.95	4.95	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	4.96	7.09	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	7.60	7.60	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.61	8.36	HGL Too High!
P34	MH13	MH14	1.00	7.60	7.60	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	7.60	8.11	HGL Too High!
P36	MH14	MH15	1.00	7.58	7.58	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	7.60	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	7.56	7.56	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	7.58	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.43	7.43	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	7.56	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.34	7.34	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	7.43	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.15	7.15	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	7.34	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.03	7.03	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	7.15	9.40	HGL ok
P-253	MH-253	MH-254	3.20	6.97	6.97	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	7.03	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**6.97**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	7.59	7.59	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.59	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	7.58	7.58	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	7.59	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	7.56	7.56	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	7.58	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	7.56	7.56	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	7.59	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	7.59	7.59	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	7.69	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	7.59	7.59	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.59	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	7.52	7.52	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	7.59	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.47	7.47	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	7.52	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.43	7.43	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	7.47	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	7.52	7.52	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.52	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	7.52	7.52	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.52	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.34	7.34	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.34	8.38	HGL ok
P-247	DI-7	MH-248	1.00	7.34	7.34	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.34	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.63	7.78	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	7.59	7.59	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	7.63	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.63	7.99	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	7.60	7.60	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.61	8.11	HGL Too High!
P40	DI12	DI11	1.00	7.59	7.59	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.59	7.19	HGL Too High!
P37	DI11	MH15	1.00	7.58	7.58	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	7.59	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.10	8.10	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.11	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.10	8.10	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	8.10	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.08	8.08	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	8.10	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.06	8.06	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	8.08	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.93	7.93	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	8.06	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.84	7.84	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	7.93	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.65	7.65	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	7.84	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.53	7.53	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	7.65	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.47	7.47	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	7.53	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**7.47**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	8.09	8.09	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.09	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.08	8.08	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	8.09	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.06	8.06	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	8.08	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.06	8.06	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	8.09	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.09	8.09	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	8.19	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.09	8.09	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.09	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.02	8.02	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	8.09	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.97	7.97	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	8.02	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.93	7.93	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	7.97	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.02	8.02	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.02	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.02	8.02	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.02	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.84	7.84	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.84	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	7.84	7.84	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.84	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	8.13	8.13	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.13	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.09	8.09	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	8.13	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.13	8.13	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.13	10.89	HGL ok
P35	DI10	MH14	1.00	8.10	8.10	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.11	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.09	8.09	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.09	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.08	8.08	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	8.09	7.09	HGL Too High!

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Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.50	8.50	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.51	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.50	8.50	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	8.50	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.48	8.48	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	8.50	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.46	8.46	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	8.48	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.33	8.33	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	8.46	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.24	8.24	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	8.33	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.05	8.05	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	8.24	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.93	7.93	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	8.05	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.87	7.87	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	7.93	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**7.87**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	8.49	8.49	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.49	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.48	8.48	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	8.49	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.46	8.46	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	8.48	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.46	8.46	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	8.49	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.49	8.49	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	8.59	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.49	8.49	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.49	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.42	8.42	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	8.49	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.37	8.37	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	8.42	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.33	8.33	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	8.37	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.42	8.42	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.42	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.42	8.42	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.42	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.24	8.24	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.24	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.24	8.24	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.24	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	8.53	8.53	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.53	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.49	8.49	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	8.53	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.53	8.53	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.53	10.89	HGL ok
P35	DI10	MH14	1.00	8.50	8.50	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.51	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.49	8.49	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.49	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.48	8.48	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	8.49	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.00	9.00	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.01	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.00	9.00	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	9.00	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.98	8.98	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	9.00	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.96	8.96	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	8.98	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.83	8.83	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	8.96	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.74	8.74	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	8.83	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.55	8.55	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	8.74	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.43	8.43	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	8.55	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	8.37	8.37	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	8.43	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**8.37**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	8.99	8.99	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.99	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.98	8.98	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	8.99	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.96	8.96	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	8.98	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.96	8.96	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	8.99	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.99	8.99	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	9.09	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.99	8.99	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.99	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.92	8.92	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	8.99	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.87	8.87	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	8.92	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.83	8.83	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	8.87	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.92	8.92	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.92	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.92	8.92	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.92	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.74	8.74	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.74	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.74	8.74	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.74	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.03	9.03	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.03	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.99	8.99	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	9.03	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.03	9.03	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.03	10.89	HGL ok
P35	DI10	MH14	1.00	9.00	9.00	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.01	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.99	8.99	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.99	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.98	8.98	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	8.99	7.09	HGL Too High!

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Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.70	9.70	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.71	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.70	9.70	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	9.70	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.68	9.68	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	9.70	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.66	9.66	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	9.68	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.53	9.53	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	9.66	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.44	9.44	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	9.53	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.25	9.25	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	9.44	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.13	9.13	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	9.25	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.07	9.07	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	9.13	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**9.07**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	9.69	9.69	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.69	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.68	9.68	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	9.69	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.66	9.66	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	9.68	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.66	9.66	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	9.69	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.69	9.69	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	9.79	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.69	9.69	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.69	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.62	9.62	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	9.69	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.57	9.57	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	9.62	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.53	9.53	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	9.57	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.62	9.62	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.62	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.62	9.62	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.62	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.44	9.44	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.44	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.44	9.44	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.44	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.73	9.73	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.73	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.69	9.69	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	9.73	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.73	9.73	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.73	10.89	HGL ok
P35	DI10	MH14	1.00	9.70	9.70	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.71	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.69	9.69	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.69	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.68	9.68	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	9.69	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.20	10.20	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.21	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.20	10.20	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	10.20	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.18	10.18	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	10.20	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.16	10.16	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	10.18	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.03	10.03	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	10.16	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.94	9.94	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	10.03	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.75	9.75	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	9.94	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.63	9.63	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	9.75	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.57	9.57	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	9.63	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**9.57**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.19	10.19	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.19	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.18	10.18	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	10.19	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.16	10.16	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	10.18	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.16	10.16	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.19	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.19	10.19	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	10.29	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.19	10.19	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.19	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.12	10.12	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	10.19	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.07	10.07	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	10.12	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.03	10.03	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	10.07	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.12	10.12	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.12	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.12	10.12	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.12	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.94	9.94	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.94	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.94	9.94	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.94	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.23	10.23	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.23	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.19	10.19	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	10.23	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.23	10.23	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.23	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.20	10.20	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.21	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.19	10.19	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.19	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.18	10.18	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	10.19	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.50	11.50	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.51	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.50	11.50	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	11.50	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.48	11.48	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	11.50	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.46	11.46	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	11.48	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.33	11.33	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	11.46	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.24	11.24	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	11.33	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.05	11.05	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	11.24	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.93	10.93	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	11.05	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.87	10.87	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	10.93	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**10.87**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.49	11.49	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.49	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.48	11.48	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	11.49	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.46	11.46	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	11.48	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.46	11.46	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.49	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.49	11.49	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	11.59	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.49	11.49	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.49	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.42	11.42	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	11.49	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.37	11.37	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	11.42	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.33	11.33	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	11.37	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.42	11.42	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.42	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.42	11.42	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.42	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.24	11.24	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.24	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.24	11.24	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.24	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.53	11.53	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.53	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.49	11.49	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	11.53	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.53	11.53	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.53	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.50	11.50	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.51	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.49	11.49	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.49	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.48	11.48	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.49	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.44	6.44	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.45	8.36	HGL ok
P34	MH13	MH14	1.00	6.44	6.44	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	6.44	8.11	HGL ok
P36	MH14	MH15	1.00	6.42	6.42	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	6.44	7.86	HGL ok
P-243	MH-15	MH-244	1.00	6.40	6.40	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	6.42	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	6.27	6.27	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	6.40	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	6.18	6.18	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	6.27	7.93	HGL ok
P-248	MH-248	MH-252	2.40	5.99	5.99	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	6.18	7.35	HGL ok
P-252	MH-252	MH-253	3.20	5.87	5.87	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	5.99	9.40	HGL ok
P-253	MH-253	MH-254	3.20	5.81	5.81	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	5.87	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**5.81**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	6.43	6.43	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.43	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	6.42	6.42	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	6.43	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	6.40	6.40	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	6.42	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	6.40	6.40	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	6.43	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	6.43	6.43	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	6.53	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	6.43	6.43	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.43	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	6.36	6.36	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	6.43	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	6.31	6.31	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	6.36	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	6.27	6.27	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	6.31	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	6.36	6.36	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.36	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	6.36	6.36	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.36	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	6.18	6.18	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.18	8.38	HGL ok
P-247	DI-7	MH-248	1.00	6.18	6.18	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.18	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.30	7.78	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	6.43	7.26	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	7.30	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.30	7.99	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	6.44	6.44	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.45	8.11	HGL ok
P40	DI12	DI11	1.00	6.43	6.43	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.43	7.19	HGL Too High!
P37	DI11	MH15	1.00	6.42	6.42	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	6.43	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.64	6.64	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.65	8.36	HGL ok
P34	MH13	MH14	1.00	6.64	6.64	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	6.64	8.11	HGL ok
P36	MH14	MH15	1.00	6.62	6.62	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	6.64	7.86	HGL ok
P-243	MH-15	MH-244	1.00	6.60	6.60	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	6.62	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	6.47	6.47	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	6.60	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	6.38	6.38	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	6.47	7.93	HGL ok
P-248	MH-248	MH-252	2.40	6.19	6.19	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	6.38	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.07	6.07	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	6.19	9.40	HGL ok
P-253	MH-253	MH-254	3.20	6.01	6.01	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	6.07	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**6.01**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	6.63	6.63	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.63	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	6.62	6.62	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	6.63	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	6.60	6.60	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	6.62	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	6.60	6.60	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	6.63	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	6.63	6.63	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	6.73	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	6.63	6.63	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.63	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	6.56	6.56	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	6.63	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	6.51	6.51	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	6.56	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	6.47	6.47	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	6.51	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	6.56	6.56	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.56	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	6.56	6.56	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.56	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	6.38	6.38	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.38	8.38	HGL ok
P-247	DI-7	MH-248	1.00	6.38	6.38	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.38	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.30	7.78	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	6.63	7.26	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	7.30	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.30	7.99	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	6.64	6.64	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.65	8.11	HGL ok
P40	DI12	DI11	1.00	6.63	6.63	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.63	7.19	HGL Too High!
P37	DI11	MH15	1.00	6.62	6.62	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	6.63	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ftnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.14	10.14	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.15	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.14	10.14	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	10.14	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.12	10.12	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	10.14	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.10	10.10	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	10.12	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.97	9.97	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	10.10	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.88	9.88	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	9.97	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.69	9.69	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	9.88	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.57	9.57	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	9.69	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.51	9.51	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	9.57	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**9.51**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.13	10.13	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.13	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.12	10.12	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	10.13	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.10	10.10	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	10.12	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.10	10.10	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.13	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.13	10.13	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	10.23	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.13	10.13	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.13	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.06	10.06	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	10.13	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.01	10.01	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	10.06	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.97	9.97	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	10.01	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.06	10.06	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.06	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.06	10.06	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.06	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.88	9.88	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.88	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.88	9.88	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.88	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.17	10.17	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.17	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.13	10.13	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	10.17	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.17	10.17	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.17	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.14	10.14	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.15	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.13	10.13	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.13	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.12	10.12	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	10.13	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.64	10.64	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.65	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.64	10.64	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	10.64	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.62	10.62	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	10.64	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.60	10.60	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	10.62	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.47	10.47	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	10.60	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.38	10.38	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	10.47	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.19	10.19	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	10.38	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.07	10.07	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	10.19	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.01	10.01	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	10.07	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**10.01**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.63	10.63	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.63	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.62	10.62	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	10.63	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.60	10.60	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	10.62	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.60	10.60	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.63	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.63	10.63	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	10.73	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.63	10.63	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.63	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.56	10.56	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	10.63	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.51	10.51	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	10.56	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.47	10.47	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	10.51	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.56	10.56	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.56	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.56	10.56	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.56	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.38	10.38	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.38	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.38	10.38	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.38	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.67	10.67	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.67	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.63	10.63	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	10.67	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.67	10.67	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.67	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.64	10.64	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.65	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.63	10.63	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.63	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.62	10.62	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	10.63	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.04	11.04	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.05	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.04	11.04	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	11.04	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.02	11.02	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	11.04	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.00	11.00	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	11.02	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.87	10.87	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	11.00	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.78	10.78	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	10.87	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.59	10.59	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	10.78	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.47	10.47	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	10.59	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.41	10.41	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	10.47	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**10.41**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.03	11.03	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.03	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.02	11.02	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	11.03	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.00	11.00	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	11.02	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.00	11.00	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.03	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.03	11.03	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	11.13	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.03	11.03	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.03	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.96	10.96	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	11.03	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.91	10.91	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	10.96	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.87	10.87	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	10.91	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.96	10.96	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.96	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.96	10.96	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.96	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.78	10.78	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.78	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.78	10.78	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.78	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.07	11.07	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.07	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.03	11.03	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	11.07	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.07	11.07	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.07	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.04	11.04	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.05	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.03	11.03	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.03	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.02	11.02	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.03	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.54	11.54	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.55	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.54	11.54	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	11.54	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.52	11.52	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	11.54	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.50	11.50	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	11.52	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.37	11.37	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	11.50	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.28	11.28	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	11.37	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.09	11.09	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	11.28	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.97	10.97	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	11.09	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.91	10.91	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	10.97	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**10.91**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.53	11.53	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.53	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.52	11.52	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	11.53	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.50	11.50	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	11.52	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.50	11.50	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.53	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.53	11.53	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	11.63	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.53	11.53	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.53	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.46	11.46	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	11.53	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.41	11.41	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	11.46	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.37	11.37	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	11.41	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.46	11.46	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.46	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.46	11.46	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.46	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.28	11.28	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.28	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.28	11.28	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.28	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.57	11.57	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.57	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.53	11.53	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	11.57	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.57	11.57	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.57	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.54	11.54	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.55	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.53	11.53	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.53	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.52	11.52	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.53	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.24	12.24	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.25	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.24	12.24	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	12.24	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.22	12.22	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	12.24	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.20	12.20	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	12.22	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.07	12.07	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	12.20	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.98	11.98	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	12.07	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.79	11.79	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	11.98	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.67	11.67	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	11.79	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.61	11.61	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	11.67	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**11.61**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.23	12.23	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.23	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.22	12.22	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	12.23	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.20	12.20	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	12.22	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.20	12.20	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.23	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.23	12.23	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	12.33	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.23	12.23	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.23	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.16	12.16	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	12.23	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.11	12.11	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	12.16	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.07	12.07	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	12.11	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.16	12.16	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.16	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.16	12.16	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.16	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.98	11.98	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.98	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.98	11.98	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.98	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.27	12.27	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.27	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.23	12.23	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	12.27	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.27	12.27	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.27	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.24	12.24	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.25	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.23	12.23	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.23	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.22	12.22	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	12.23	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.74	12.74	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.75	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.74	12.74	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	12.74	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.72	12.72	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	12.74	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.70	12.70	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	12.72	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.57	12.57	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	12.70	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.48	12.48	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	12.57	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.29	12.29	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	12.48	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	12.17	12.17	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	12.29	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	12.11	12.11	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	12.17	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**12.11**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.73	12.73	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.73	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.72	12.72	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	12.73	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.70	12.70	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	12.72	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.70	12.70	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.73	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.73	12.73	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	12.83	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.73	12.73	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.73	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.66	12.66	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	12.73	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.61	12.61	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	12.66	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.57	12.57	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	12.61	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.66	12.66	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.66	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.66	12.66	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.66	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.48	12.48	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.48	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.48	12.48	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.48	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.77	12.77	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.77	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.73	12.73	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	12.77	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.77	12.77	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.77	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.74	12.74	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.75	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.73	12.73	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.73	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.72	12.72	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	12.73	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	14.04	14.04	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.05	8.36	HGL Too High!
P34	MH13	MH14	1.00	14.04	14.04	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	14.04	8.11	HGL Too High!
P36	MH14	MH15	1.00	14.02	14.02	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	14.04	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	14.00	14.00	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	14.02	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	13.87	13.87	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	14.00	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	13.78	13.78	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	13.87	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	13.59	13.59	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	13.78	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	13.47	13.47	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	13.59	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	13.41	13.41	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	13.47	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**13.41**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	14.03	14.03	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.03	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	14.02	14.02	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	14.03	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	14.00	14.00	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	14.02	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	14.00	14.00	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	14.03	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	14.03	14.03	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	14.13	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	14.03	14.03	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.03	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.96	13.96	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	14.03	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	13.91	13.91	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	13.96	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	13.87	13.87	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	13.91	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.96	13.96	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.96	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.96	13.96	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.96	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	13.78	13.78	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.78	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	13.78	13.78	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.78	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	14.07	14.07	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.07	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	14.03	14.03	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	14.07	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	14.07	14.07	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.07	10.89	HGL Too High!
P35	DI10	MH14	1.00	14.04	14.04	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.05	8.11	HGL Too High!
P40	DI12	DI11	1.00	14.03	14.03	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.03	7.19	HGL Too High!
P37	DI11	MH15	1.00	14.02	14.02	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	14.03	7.09	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 5 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: Market Street Outfall (North) | Storm Frequency: 10 -year (50-year for sumps)
4

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P33	DI24	MH13	4615	1621	6236	0.14	0.75	0.11	0.11	6.0	6.17	6.11	0.7	15	30	0.012	0.0001	0.005	4.1	5.1	2.9	0.17	6.34	4.17	4.01	Q ok
P34	MH13	MH14	1	0	1	0.00	0.95	0.00	0.11	6.0	6.34	6.08	0.7	15	44	0.012	0.0001	0.005	4.1	5.0	2.9	0.26	6.60	3.91	3.68	Q ok
P36	MH14	MH15	1	0	1	0.00	0.95	0.00	0.22	6.0	6.60	6.01	1.3	15	87	0.012	0.0004	0.005	4.1	5.0	3.4	0.43	7.03	3.57	3.12	Q ok
P-243	MH-15	MH-244	1	0	1	0.00	0.95	0.00	0.35	6.0	7.03	5.90	**2.09**	15	23	0.012	0.000894	0.0052	4.1	**5.1**	3.8	0.10	7.13	3.02	2.90	Q ok
P-244	MH-244	MH-245	1	0	1	0.00	0.95	0.00	1.85	6.0	7.13	5.88	**10.87**	24	79	0.012	0.001967	0.0089	7.3	**23.1**	7.1	0.18	7.31	2.80	2.10	Q ok
P-245	MH-245	MH-248	1	0	1	0.00	0.95	0.00	5.16	6.0	7.31	5.83	**30.05**	**36**	33	0.012	0.001729	0.0030	5.6	**39.8**	6.2	0.09	7.40	2.00	1.90	Q ok
P-248	MH-248	MH-252	1	0	1	0.00	0.95	0.00	5.53	6.0	7.40	5.80	**32.07**	**36**	115	0.012	0.001970	0.0033	5.9	**41.5**	6.5	0.29	7.70	1.80	1.42	Q ok
P-252	MH-252	MH-253	1	0	1	0.00	0.95	0.00	5.84	6.0	7.70	5.72	**33.41**	48	38	0.012	0.000461	0.0032	7.0	**87.4**	6.4	0.10	7.80	1.32	1.20	Q ok
P-253	MH-253	MH-254	1	0	1	0.00	0.95	0.00	5.84	6.0	7.80	5.70	**33.26**	48	102	0.012	0.000457	0.0031	6.9	**87.2**	6.4	0.27	8.06	1.10	0.78	Q ok
P-254	MH-254	OUTFALL	1	0	1	0.00	0.95	0.00	5.84	6.0	8.06	5.62	**32.80**	48	89	0.012	0.000444	0.0030	6.8	**85.7**	6.3	0.24	8.30	0.68	0.41	Q ok
P-240	DI-240	DI-241	4485	497	4982	0.11	0.87	0.10	0.10	6.0	0.00	6.16	**0.62**	15	30	0.012	0.000077	0.0050	4.0	**4.9**	2.4	0.21	6.21	3.72	3.57	Q ok
P-241	DI-241	DI-242	3403	140	3543	0.08	0.92	0.07	0.17	6.0	3.72	6.16	**1.08**	15	20	0.012	0.000237	0.0050	4.0	**4.9**	3.0	0.11	6.11	3.47	3.37	Q ok
P-242	DI-242	MH-244	6783	82	6865	0.16	0.94	0.15	0.32	6.0	3.47	6.16	**1.99**	15	12	0.012	0.000809	0.0050	4.0	**4.9**	3.7	0.05	6.05	3.27	3.21	Q ok
LIMIT FUTURE FLOW FROM A3 TO MACTH 36" PIPE CAPACITY TO MEET CLEARANCE/COVER REQUIREMENTS FOR P-245 & P-248. HOLE 48" OUTFALL																										
ASSUMED FUTURE FLOW ROUTED INTO NEW OUTFALL																										
Existing Offsite Area routed through Ex. 15" TC; Re-Routed to MH-244																										
P-Offsite	Exist Offsite	MH-244	52965	4000	56965	1.31	0.90	1.17	1.17	6.0	0.00	6.16	**7.22**	24	39	0.012	0.000868	0.0051	5.6	**17.6**	5.1	0.13	6.13	3.10	2.90	Q ok
Assumed 1/3 of Future Area 3 Routed to A St Future Trunk Line to P-261																										
P-Future A3	Addl A3	MH-261	**120000**	**0**	**120000**	2.75	0.95	2.62	2.62	6.0	0.00	6.16	**16.13**	30	98	0.012	0.001317	0.0096	8.9	**43.5**	8.0	0.20	6.20	4.20	3.26	Q ok
REMOVED 50,000SF OF A3 FROM ENTERING OUTFALL																										
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																										
P-260	DI-39	MH-261	4465	0	4465	0.10	0.95	0.10	0.10	6.0	0.00	6.16	**0.60**	15	44	0.012	0.000074	0.0032	3.2	**3.9**	2.3	0.33	6.33	3.40	3.26	Q ok
Exist Parcel Flow, Add Future A3 here																										
P-261	MH-261	MH-264	16653	1127	17780	0.41	0.90	0.37	3.08	6.0	6.33	6.08	**18.75**	36	145	0.012	0.000674	0.0030	5.6	**39.8**	5.5	0.44	6.77	3.16	2.72	Q ok
P-264	MH-264	MH-265	0	0	0	0.00	0.00	0.00	3.31	6.0	6.77	5.96	**19.70**	36	61	0.012	0.000743	0.0031	5.7	**40.3**	5.6	0.18	6.95	2.46	2.27	Q ok
P-265	MH-265	MH-245	0	0	0	0.00	0.00	0.00	3.31	6.0	6.95	5.93	**19.62**	36	*46*	0.012	0.000737	0.0037	6.2	**43.9**	6.0	0.13	7.08	2.17	2.00	Q ok
															STUB		22 LF	act length					act.	2.08		
P-262	DI-35&36	MH-264	5579	0	5579	0.13	0.95	0.12	0.12	6.0	0.00	6.16	**0.75**	15	36	0.012	0.000115	0.0031	3.2	**3.9**	2.4	0.25	6.25	3.38	3.27	Q ok
P-263	DI-37&38	MH-264	4770	0	4770	0.11	0.95	0.10	0.10	6.0	0.00	6.16	**0.64**	15	18	0.012	0.000084	0.0056	4.3	**5.2**	2.6	0.12	6.12	2.66	2.56	Q ok
Inlets Constructed in ASI																										
P-246	DI-6	MH-248	9946	0	9946	0.23	0.95	0.22	0.22	6.0	0.00	6.16	**1.34**	15	23	0.012	0.000365	0.0052	4.1	**5.1**	3.4	0.11	6.11	4.72	4.60	Q ok
P-247	DI-7	MH-248	7066	0	7066	0.16	0.95	0.15	0.15	6.0	0.00	6.16	**0.95**	15	26	0.012	0.000184	0.0046	3.9	**4.8**	2.9	0.15	6.15	4.74	4.62	Q ok
P-250	DI-8	MH-251	8718	0	8718	0.20	0.95	0.19	0.19	6.0	0.00	6.16	**1.17**	15	18	0.012	0.000280	0.0050	4.0	**4.9**	3.3	0.09	6.09	6.87	6.78	Q ok
P-251	MH-251	MH-252	0	0	0	0.00	0.00	0.00	0.31	6.0	6.10	6.14	**1.89**	15	54	0.012	0.000733	0.0078	5.0	**6.2**	4.3	0.21	6.31	6.68	6.26	Q ok
P-249	DI-9	MH-248	5442	0	5442	0.12	0.95	0.12	0.12	6.0	0.00	6.16	**0.73**	15	16	0.012	0.000109	0.0044	3.8	**4.6**	2.6	0.10	6.10	7.06	6.99	Q ok
P35	DI10	MH14	4962	681	5643	0.13	0.86	0.11	0.11	6.0	0.00	8.51	0.9	15	18	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.92	3.83	Q ok
P40	DI12	DI11	2375	125	2500	0.06	0.91	0.05	0.05	6.0	0.00	8.51	0.4	15	39	0.012	0.0000	0.005	4.0	4.9	2.4	0.27	6.27	3.67	3.47	Q ok
P37	DI11	MH15	3715	653	4368	0.10	0.83	0.08	0.14	6.0	6.27	8.40	1.1	15	18	0.012	0.0003	0.005	4.0	4.9	3.3	0.09	6.36	3.33	3.24	Q ok
	FUTURE PIPES FOR AREA 3, NOT INCLUDED IN AREA 1 SUBMITTAL																									

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ftnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	5.36	5.36	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.37	8.36	HGL ok
P34	MH13	MH14	1.00	5.36	5.36	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	5.36	8.11	HGL ok
P36	MH14	MH15	1.00	5.32	5.32	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	5.36	7.86	HGL ok
P-243	MH-15	MH-244	1.00	5.29	5.29	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	5.32	7.17	HGL ok
P-244	MH-244	MH-245	1.60	5.07	5.07	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	5.29	7.35	HGL ok
P-245	MH-245	MH-248	2.40	4.91	4.91	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	5.07	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.60	4.60	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	4.91	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.09	4.40	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	4.60	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.72	3.98	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	4.09	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.20**	**3.61**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**3.72**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	5.34	5.34	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.35	6.85	HGL ok
P-241	DI-241	DI-242	1.00	5.33	5.33	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	5.34	6.98	HGL ok
P-242	DI-242	MH-244	1.00	5.29	5.29	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	5.33	7.07	HGL ok
P-Offsite	Exist Offsite	MH-244	1.60	5.29	5.29	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	5.35	7.07	HGL ok
P-Future A3	Addl A3	MH-261	2.00	5.34	5.34	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	5.51	7.20	HGL ok
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	5.34	5.34	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.34	6.78	HGL ok
P-261	MH-261	MH-264	2.40	5.22	5.22	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	5.34	6.80	HGL ok
P-264	MH-264	MH-265	2.40	5.14	5.14	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	5.22	6.48	HGL ok
P-265	MH-265	MH-245	2.40	5.07	5.07	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	5.14	6.82	HGL ok
P-262	DI-35&36	MH-264	1.00	5.22	5.22	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.22	7.04	HGL ok
P-263	DI-37&38	MH-264	1.00	5.22	5.22	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.22	6.35	HGL ok
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	4.91	5.60	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.61	8.38	HGL ok
P-247	DI-7	MH-248	1.00	4.91	5.62	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.63	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.32	7.78	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	5.35	7.26	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	7.32	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.32	7.99	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	5.36	5.36	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.36	8.11	HGL ok
P40	DI12	DI11	1.00	5.33	5.33	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.33	7.19	HGL ok
P37	DI11	MH15	1.00	5.32	5.32	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	5.33	7.09	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	5.36	5.36	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.37	8.36	HGL ok
P34	MH13	MH14	1.00	5.36	5.36	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	5.36	8.11	HGL ok
P36	MH14	MH15	1.00	5.32	5.32	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	5.36	7.86	HGL ok
P-243	MH-15	MH-244	1.00	5.29	5.29	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	5.32	7.17	HGL ok
P-244	MH-244	MH-245	1.60	5.07	5.07	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	5.29	7.35	HGL ok
P-245	MH-245	MH-248	2.40	4.91	4.91	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	5.07	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.60	4.60	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	4.91	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.09	4.40	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	4.60	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.72	3.98	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	4.09	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.40**	**3.61**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**3.72**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	5.34	5.34	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.35	6.85	HGL ok
P-241	DI-241	DI-242	1.00	5.33	5.33	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	5.34	6.98	HGL ok
P-242	DI-242	MH-244	1.00	5.29	5.29	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	5.33	7.07	HGL ok
P-Offsite	Exist Offsite	MH-244	1.60	5.29	5.29	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	5.35	7.07	HGL ok
P-Future A3	Addl A3	MH-261	2.00	5.34	5.34	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	5.51	7.20	HGL ok
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	5.34	5.34	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.34	6.78	HGL ok
P-261	MH-261	MH-264	2.40	5.22	5.22	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	5.34	6.80	HGL ok
P-264	MH-264	MH-265	2.40	5.14	5.14	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	5.22	6.48	HGL ok
P-265	MH-265	MH-245	2.40	5.07	5.07	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	5.14	6.82	HGL ok
P-262	DI-35&36	MH-264	1.00	5.22	5.22	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.22	7.04	HGL ok
P-263	DI-37&38	MH-264	1.00	5.22	5.22	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.22	6.35	HGL ok
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	4.91	5.60	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.61	8.38	HGL ok
P-247	DI-7	MH-248	1.00	4.91	5.62	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.63	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.32	7.78	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	5.35	7.26	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	7.32	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.32	7.99	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	5.36	5.36	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.36	8.11	HGL ok
P40	DI12	DI11	1.00	5.33	5.33	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.33	7.19	HGL ok
P37	DI11	MH15	1.00	5.32	5.32	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	5.33	7.09	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.08	8.08	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.09	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.07	8.07	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	8.08	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.04	8.04	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	8.07	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.01	8.01	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.04	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.79	7.79	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	8.01	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.63	7.63	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	7.79	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.32	7.32	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	7.63	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.12	7.12	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	7.32	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.01	7.01	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	7.12	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**7.01**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	8.06	8.06	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.07	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.05	8.05	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	8.06	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.01	8.01	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	8.05	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.01	8.01	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	8.07	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.06	8.06	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	8.23	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.06	8.06	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.06	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	7.94	7.94	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	8.06	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.86	7.86	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	7.94	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.79	7.79	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	7.86	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	7.94	7.94	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.94	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	7.94	7.94	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.94	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.63	7.63	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.65	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	7.63	7.63	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.64	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	8.13	8.13	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.14	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.07	8.07	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	8.13	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.13	8.13	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.13	10.89	HGL ok
P35	DI10	MH14	1.00	8.07	8.07	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.08	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.05	8.05	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.05	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.04	8.04	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	8.05	7.09	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ftnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.58	8.58	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.59	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.57	8.57	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	8.58	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.54	8.54	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	8.57	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.51	8.51	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.54	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.29	8.29	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	8.51	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.13	8.13	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	8.29	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.82	7.82	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	8.13	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.62	7.62	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	7.82	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.51	7.51	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	7.62	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**7.51**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	8.56	8.56	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.57	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.55	8.55	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	8.56	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.51	8.51	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	8.55	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.51	8.51	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	8.57	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.56	8.56	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	8.73	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.56	8.56	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.56	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.44	8.44	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	8.56	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.36	8.36	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	8.44	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.29	8.29	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	8.36	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.44	8.44	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.44	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.44	8.44	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.44	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.13	8.13	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.15	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.13	8.13	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.14	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	8.63	8.63	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.64	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.57	8.57	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	8.63	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.63	8.63	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.63	10.89	HGL ok
P35	DI10	MH14	1.00	8.57	8.57	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.58	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.55	8.55	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.55	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.54	8.54	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	8.55	7.09	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.98	8.98	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.99	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.97	8.97	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	8.98	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.94	8.94	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	8.97	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.91	8.91	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	8.94	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.69	8.69	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	8.91	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.53	8.53	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	8.69	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.22	8.22	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	8.53	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.02	8.02	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	8.22	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.91	7.91	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	8.02	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**7.91**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	8.96	8.96	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.97	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.95	8.95	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	8.96	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.91	8.91	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	8.95	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.91	8.91	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	8.97	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.96	8.96	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	9.13	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.96	8.96	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.96	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.84	8.84	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	8.96	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.76	8.76	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	8.84	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.69	8.69	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	8.76	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.84	8.84	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.84	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.84	8.84	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.84	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.53	8.53	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.55	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.53	8.53	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.54	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.03	9.03	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.04	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.97	8.97	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	9.03	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.03	9.03	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.03	10.89	HGL ok
P35	DI10	MH14	1.00	8.97	8.97	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.98	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.95	8.95	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.95	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.94	8.94	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	8.95	7.09	HGL Too High!

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RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ftnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.48	9.48	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.49	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.47	9.47	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	9.48	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.44	9.44	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	9.47	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.41	9.41	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	9.44	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.19	9.19	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	9.41	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.03	9.03	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	9.19	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.72	8.72	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	9.03	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.52	8.52	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	8.72	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	8.41	8.41	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	8.52	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**8.41**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	9.46	9.46	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.47	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.45	9.45	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	9.46	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.41	9.41	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	9.45	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.41	9.41	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	9.47	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.46	9.46	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	9.63	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.46	9.46	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.46	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.34	9.34	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	9.46	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.26	9.26	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	9.34	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.19	9.19	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	9.26	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.34	9.34	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.34	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.34	9.34	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.34	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.03	9.03	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.05	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.03	9.03	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.04	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.53	9.53	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.54	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.47	9.47	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	9.53	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.53	9.53	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.53	10.89	HGL ok
P35	DI10	MH14	1.00	9.47	9.47	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.48	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.45	9.45	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.45	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.44	9.44	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	9.45	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.18	10.18	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.19	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.17	10.17	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	10.18	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.14	10.14	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	10.17	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.11	10.11	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.14	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.89	9.89	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	10.11	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.73	9.73	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	9.89	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.42	9.42	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	9.73	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.22	9.22	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	9.42	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.11	9.11	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	9.22	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**9.11**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.16	10.16	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.17	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.15	10.15	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	10.16	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.11	10.11	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	10.15	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.11	10.11	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	10.17	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.16	10.16	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	10.33	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.16	10.16	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.16	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.04	10.04	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	10.16	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.96	9.96	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	10.04	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.89	9.89	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	9.96	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.04	10.04	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.04	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.04	10.04	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.04	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.73	9.73	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.75	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.73	9.73	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.74	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.23	10.23	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.24	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.17	10.17	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	10.23	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.23	10.23	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.23	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.17	10.17	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.18	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.15	10.15	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.15	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.14	10.14	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	10.15	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.68	10.68	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.69	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.67	10.67	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	10.68	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.64	10.64	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	10.67	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.61	10.61	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.64	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.39	10.39	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	10.61	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.23	10.23	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	10.39	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.92	9.92	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	10.23	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.72	9.72	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	9.92	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.61	9.61	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	9.72	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**9.61**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.66	10.66	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.67	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.65	10.65	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	10.66	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.61	10.61	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	10.65	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.61	10.61	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	10.67	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.66	10.66	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	10.83	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.66	10.66	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.66	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.54	10.54	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	10.66	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.46	10.46	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	10.54	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.39	10.39	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	10.46	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.54	10.54	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.54	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.54	10.54	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.54	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.23	10.23	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.25	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.23	10.23	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.24	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.73	10.73	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.74	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.67	10.67	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	10.73	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.73	10.73	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.73	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.67	10.67	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.68	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.65	10.65	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.65	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.64	10.64	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	10.65	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.98	11.98	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.99	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.97	11.97	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	11.98	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.94	11.94	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	11.97	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.91	11.91	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.94	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.69	11.69	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	11.91	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.53	11.53	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	11.69	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.22	11.22	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	11.53	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.02	11.02	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	11.22	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.91	10.91	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	11.02	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**10.91**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.96	11.96	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.97	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.95	11.95	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	11.96	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.91	11.91	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	11.95	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.91	11.91	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	11.97	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.96	11.96	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	12.13	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.96	11.96	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.96	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.84	11.84	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	11.96	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.76	11.76	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	11.84	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.69	11.69	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	11.76	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.84	11.84	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.84	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.84	11.84	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.84	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.53	11.53	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.55	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.53	11.53	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.54	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.03	12.03	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.04	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.97	11.97	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	12.03	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.03	12.03	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.03	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.97	11.97	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.98	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.95	11.95	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.95	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.94	11.94	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.95	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.92	6.92	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.93	8.36	HGL ok
P34	MH13	MH14	1.00	6.91	6.91	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	6.92	8.11	HGL ok
P36	MH14	MH15	1.00	6.88	6.88	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	6.91	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	6.85	6.85	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	6.88	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	6.63	6.63	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	6.85	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	6.47	6.47	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	6.63	7.93	HGL ok
P-248	MH-248	MH-252	2.40	6.16	6.16	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	6.47	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	5.96	5.96	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	6.16	9.40	HGL ok
P-253	MH-253	MH-254	3.20	5.85	5.85	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	5.96	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**5.85**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	6.90	6.90	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.91	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	6.89	6.89	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	6.90	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	6.85	6.85	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	6.89	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	6.85	6.85	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	6.91	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	6.90	6.90	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	7.07	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	6.90	6.90	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.90	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	6.78	6.78	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	6.90	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	6.70	6.70	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	6.78	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	6.63	6.63	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	6.70	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	6.78	6.78	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.78	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	6.78	6.78	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.78	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	6.47	6.47	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.49	8.38	HGL ok
P-247	DI-7	MH-248	1.00	6.47	6.47	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.48	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.32	7.78	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	6.91	7.26	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	7.32	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.32	7.99	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	6.91	6.91	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.92	8.11	HGL ok
P40	DI12	DI11	1.00	6.89	6.89	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.89	7.19	HGL Too High!
P37	DI11	MH15	1.00	6.88	6.88	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	6.89	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	7.12	7.12	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.13	8.36	HGL ok
P34	MH13	MH14	1.00	7.11	7.11	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	7.12	8.11	HGL Too High!
P36	MH14	MH15	1.00	7.08	7.08	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	7.11	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	7.05	7.05	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	7.08	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	6.83	6.83	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	7.05	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	6.67	6.67	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	6.83	7.93	HGL ok
P-248	MH-248	MH-252	2.40	6.36	6.36	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	6.67	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.16	6.16	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	6.36	9.40	HGL ok
P-253	MH-253	MH-254	3.20	6.05	6.05	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	6.16	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**6.05**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	7.10	7.10	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.11	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	7.09	7.09	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	7.10	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	7.05	7.05	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	7.09	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	7.05	7.05	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	7.11	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	7.10	7.10	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	7.27	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	7.10	7.10	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.10	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	6.98	6.98	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	7.10	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	6.90	6.90	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	6.98	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	6.83	6.83	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	6.90	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	6.98	6.98	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.98	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	6.98	6.98	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.98	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	6.67	6.67	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.69	8.38	HGL ok
P-247	DI-7	MH-248	1.00	6.67	6.67	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.68	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.32	7.78	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	7.11	7.26	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	7.32	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.32	7.99	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	7.11	7.11	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.12	8.11	HGL Too High!
P40	DI12	DI11	1.00	7.09	7.09	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.09	7.19	HGL Too High!
P37	DI11	MH15	1.00	7.08	7.08	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	7.09	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.62	10.62	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.63	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.61	10.61	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	10.62	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.58	10.58	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	10.61	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.55	10.55	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	10.58	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.33	10.33	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	10.55	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.17	10.17	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	10.33	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.86	9.86	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	10.17	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.66	9.66	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	9.86	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.55	9.55	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	9.66	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**9.55**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.60	10.60	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.61	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.59	10.59	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	10.60	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.55	10.55	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	10.59	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.55	10.55	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	10.61	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.60	10.60	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	10.77	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.60	10.60	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.60	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.48	10.48	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	10.60	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.40	10.40	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	10.48	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.33	10.33	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	10.40	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.48	10.48	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.48	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.48	10.48	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.48	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.17	10.17	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.19	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.17	10.17	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.18	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.67	10.67	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.68	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.61	10.61	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	10.67	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.67	10.67	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.67	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.61	10.61	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.62	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.59	10.59	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.59	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.58	10.58	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	10.59	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.12	11.12	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.13	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.11	11.11	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	11.12	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.08	11.08	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	11.11	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.05	11.05	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.08	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.83	10.83	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	11.05	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.67	10.67	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	10.83	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.36	10.36	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	10.67	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.16	10.16	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	10.36	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.05	10.05	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	10.16	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**10.05**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.10	11.10	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.11	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.09	11.09	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	11.10	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.05	11.05	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	11.09	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.05	11.05	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	11.11	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.10	11.10	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	11.27	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.10	11.10	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.10	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.98	10.98	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	11.10	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.90	10.90	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	10.98	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.83	10.83	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	10.90	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.98	10.98	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.98	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.98	10.98	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.98	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.67	10.67	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.69	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.67	10.67	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.68	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.17	11.17	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.18	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.11	11.11	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	11.17	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.17	11.17	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.17	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.11	11.11	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.12	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.09	11.09	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.09	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.08	11.08	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.09	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.52	11.52	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.53	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.51	11.51	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	11.52	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.48	11.48	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	11.51	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.45	11.45	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.48	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.23	11.23	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	11.45	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.07	11.07	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	11.23	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.76	10.76	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	11.07	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.56	10.56	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	10.76	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.45	10.45	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	10.56	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**10.45**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.50	11.50	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.51	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.49	11.49	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	11.50	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.45	11.45	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	11.49	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.45	11.45	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	11.51	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.50	11.50	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	11.67	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.50	11.50	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.50	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.38	11.38	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	11.50	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.30	11.30	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	11.38	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.23	11.23	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	11.30	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.38	11.38	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.38	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.38	11.38	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.38	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.07	11.07	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.09	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.07	11.07	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.08	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.57	11.57	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.58	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.51	11.51	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	11.57	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.57	11.57	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.57	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.51	11.51	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.52	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.49	11.49	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.49	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.48	11.48	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.49	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.02	12.02	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.03	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.01	12.01	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	12.02	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.98	11.98	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	12.01	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.95	11.95	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	11.98	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.73	11.73	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	11.95	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.57	11.57	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	11.73	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.26	11.26	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	11.57	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.06	11.06	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	11.26	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.95	10.95	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	11.06	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**10.95**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.00	12.00	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.01	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.99	11.99	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	12.00	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.95	11.95	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	11.99	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.95	11.95	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	12.01	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.00	12.00	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	12.17	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.00	12.00	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.00	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.88	11.88	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	12.00	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.80	11.80	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	11.88	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.73	11.73	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	11.80	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.88	11.88	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.88	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.88	11.88	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.88	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.57	11.57	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.59	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.57	11.57	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.58	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.07	12.07	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.08	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.01	12.01	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	12.07	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.07	12.07	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.07	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.01	12.01	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.02	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.99	11.99	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.99	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.98	11.98	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.99	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE d'downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.72	12.72	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.73	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.71	12.71	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	12.72	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.68	12.68	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	12.71	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.65	12.65	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	12.68	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.43	12.43	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	12.65	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.27	12.27	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	12.43	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.96	11.96	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	12.27	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.76	11.76	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	11.96	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.65	11.65	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	11.76	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**11.65**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.70	12.70	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.71	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.69	12.69	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	12.70	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.65	12.65	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	12.69	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.65	12.65	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	12.71	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.70	12.70	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	12.87	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.70	12.70	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.70	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.58	12.58	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	12.70	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.50	12.50	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	12.58	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.43	12.43	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	12.50	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.58	12.58	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.58	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.58	12.58	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.58	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.27	12.27	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.29	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.27	12.27	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.28	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.77	12.77	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.78	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.71	12.71	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	12.77	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.77	12.77	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.77	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.71	12.71	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.72	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.69	12.69	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.69	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.68	12.68	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	12.69	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.22	13.22	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.23	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.21	13.21	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	13.22	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.18	13.18	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	13.21	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.15	13.15	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.18	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.93	12.93	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	13.15	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.77	12.77	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	12.93	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.46	12.46	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	12.77	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	12.26	12.26	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	12.46	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	12.15	12.15	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	12.26	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**12.15**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.20	13.20	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.21	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.19	13.19	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	13.20	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.15	13.15	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	13.19	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.15	13.15	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	13.21	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.20	13.20	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	13.37	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.20	13.20	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.20	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.08	13.08	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	13.20	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	13.00	13.00	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	13.08	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.93	12.93	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	13.00	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.08	13.08	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.08	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.08	13.08	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.08	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.77	12.77	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.79	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.77	12.77	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.78	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.27	13.27	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.28	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.21	13.21	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	13.27	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.27	13.27	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.27	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.21	13.21	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.22	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.19	13.19	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.19	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.18	13.18	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	13.19	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignt.: add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	14.52	14.52	15	0.7	0.5	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.53	8.36	HGL Too High!
P34	MH13	MH14	1.00	14.51	14.51	15	0.7	0.5	0	44.2	0.0001	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	14.52	8.11	HGL Too High!
P36	MH14	MH15	1.00	14.48	14.48	15	1.3	1.1	0	87.2	0.0004	0.03	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	0	0.00	0.01	1.3	0.5	0.00	0.03	14.51	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	14.45	14.45	15	2.1	1.7	12.7	23	0.0009	0.02	0	0.00	0.01	1.4	1.1	0.0	1.1	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.48	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	14.23	14.23	24	10.9	3.5	45	79	0.0020	0.16	0	0.00	0.05	3.6	3.2	16.6	2.3	0.0	90	0.06	0.13	1.0	0.5	0.07	0.22	14.45	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	14.07	14.07	36	30.0	4.3	0	33	0.0017	0.06	1	0.00	0.07	37.6	54.4	0.0	2.8	0.0	90	0.08	0.20	1.0	0.5	0.10	0.15	14.23	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	13.76	13.76	36	32.1	4.5	90	115	0.0020	0.23	2	0.00	0.08	127.7	1.5	0.7	4.3	0.1	0	0.00	0.18	1.0	0.5	0.09	0.32	14.07	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	13.56	13.56	48	33.4	2.7	90	38	0.0005	0.02	0	0.00	0.03	145.5	2.9	0.0	4.5	0.1	90	0.22	0.36	1.0	0.5	0.18	0.20	13.76	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	13.45	13.45	48	33.3	2.6	16.6	102	0.0005	0.05	0	0.00	0.03	127.7	0.0	0.0	4.3	0.1	0	0.00	0.13	1.0	0.5	0.06	0.11	13.56	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**32.8**	**2.6**	**0**	**89**	**0.0004**	**0.04**	**0**	**0.00**	**0.03**	**88.8**	**0.0**	**0.0**	**2.7**	**0.0**	**90**	**0.08**	**0.14**	**1.0**	**0.5**	**0.07**	**0.11**	**13.45**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	14.50	14.50	15	0.6	0.5	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.51	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	14.49	14.49	15	1.1	0.9	90	20	0.0002	0.00	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	1.0	0.01	0.01	14.50	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	14.45	14.45	15	2.0	1.6	90	12	0.0008	0.01	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.3	1.0	0.03	0.04	14.49	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	14.45	14.45	24	7.2	2.3	90	39	0.0009	0.03	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.05	14.51	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	14.50	14.50	30	16.1	3.3	90	98	0.0013	0.13	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.17	14.67	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	14.50	14.50	15	0.6	0.5	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.50	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	14.38	14.38	36	18.8	2.7	0	145	0.0007	0.10	0	0.00	0.03	0.3	0.0	0.0	0.5	0.0	90	0.00	0.03	1.3	0.5	0.02	0.12	14.50	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	14.30	14.30	36	19.7	2.8	0	61	0.0007	0.05	0	0.00	0.03	49.8	0.5	0.3	2.7	0.0	0	0.00	0.07	1.0	0.5	0.03	0.08	14.38	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	14.23	14.23	36	19.6	2.8	90	46	0.0007	0.03	0	0.00	0.03	54.9	0.0	0.0	2.8	0.0	0	0.00	0.07	1.0	0.5	0.04	0.07	14.30	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	14.38	14.38	15	0.7	0.6	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.38	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	14.38	14.38	15	0.6	0.5	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.38	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	14.07	14.07	15	1.3	1.1	90	23	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.09	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	14.07	14.07	15	0.9	0.8	90	26	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.08	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	14.57	14.57	15	1.2	1.0	85.5	18	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.58	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	14.51	14.51	15	1.9	1.5	91.5	54	0.0007	0.04	0	0.00	0.01	1.1	0.4	0.0	1.0	0.0	85.5	0.01	0.02	1.0	1.0	0.02	0.06	14.57	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	14.57	14.57	15	0.7	0.6	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.57	10.89	HGL Too High!
P35	DI10	MH14	1.00	14.51	14.51	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.52	8.11	HGL Too High!
P40	DI12	DI11	1.00	14.49	14.49	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.49	7.19	HGL Too High!
P37	DI11	MH15	1.00	14.48	14.48	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	14.49	7.09	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 5 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: Market Street Outfall (North) | Storm Frequency: 25 -year (50-year for sumps)
4

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P33	DI24	MH13	4615	1621	6236	0.14	0.82	0.12	0.12	6.0	6.17	6.78	0.8	15	30	0.012	0.0001	0.005	4.1	5.1	2.9	0.17	6.34	4.17	4.01	Q ok
P34	MH13	MH14	1	0	1	0.00	1.00	0.00	0.12	6.0	6.34	6.75	0.8	15	44	0.012	0.0001	0.005	4.1	5.0	2.9	0.26	6.60	3.91	3.68	Q ok
P36	MH14	MH15	1	0	1	0.00	1.00	0.00	0.24	6.0	6.60	6.67	1.6	15	87	0.012	0.0005	0.005	4.1	5.0	3.5	0.42	7.01	3.57	3.12	Q ok
P-243	MH-15	MH-244	1	0	1	0.00	1.00	0.00	0.39	6.0	7.01	6.55	**2.55**	15	23	0.012	0.001331	0.0052	4.1	**5.1**	4.1	0.09	7.11	3.02	2.90	Q ok
P-244	MH-244	MH-245	1	0	1	0.00	1.00	0.00	2.03	6.0	7.11	6.52	**13.22**	24	79	0.012	0.002910	0.0089	7.3	**23.1**	7.5	0.18	7.28	2.80	2.10	Q ok
P-245	MH-245	MH-248	1	0	1	0.00	1.00	0.00	5.53	6.0	7.28	6.46	**35.72**	**36**	33	0.012	0.002444	0.0030	5.6	**39.8**	6.4	0.09	7.37	2.00	1.90	Q ok
P-248	MH-248	MH-252	1	0	1	0.00	1.00	0.00	5.92	6.0	7.37	6.43	**38.07**	**36**	115	0.012	0.002776	0.0033	5.9	**41.5**	6.7	0.29	7.65	1.80	1.42	Q ok
P-252	MH-252	MH-253	1	0	1	0.00	1.00	0.00	6.24	6.0	7.65	6.35	**39.62**	48	38	0.012	0.000648	0.0032	7.0	**87.4**	6.8	0.09	7.75	1.32	1.20	Q ok
P-253	MH-253	MH-254	1	0	1	0.00	1.00	0.00	6.24	6.0	7.75	6.35	**39.62**	48	102	0.012	0.000648	0.0031	6.9	**87.2**	6.7	0.25	8.00	1.10	0.78	Q ok
P-254	MH-254	OUTFALL	1	0	1	0.00	1.00	0.00	6.24	6.0	8.00	6.26	**39.08**	48	89	0.012	0.000631	0.0030	6.8	**85.7**	6.6	0.22	8.23	0.68	0.41	Q ok
P-240	DI-240	DI-241	4485	497	4982	0.11	0.96	0.11	0.11	6.0	0.00	6.84	**0.75**	15	30	0.012	0.000115	0.0050	4.0	**4.9**	2.8	0.18	6.18	3.72	3.57	Q ok
P-241	DI-241	DI-242	3403	140	3543	0.08	1.00	0.08	0.19	6.0	3.72	6.84	**1.31**	15	20	0.012	0.000349	0.0050	4.0	**4.9**	3.3	0.10	6.10	3.47	3.37	Q ok
P-242	DI-242	MH-244	6783	82	6865	0.16	1.00	0.16	0.35	6.0	3.47	6.84	**2.39**	15	12	0.012	0.001162	0.0050	4.0	**4.9**	4.0	0.05	6.05	3.27	3.21	Q ok
LIMIT FUTURE FLOW FROM A3 TO MACTH 36" PIPE CAPACITY TO MEET CLEARANCE/COVER REQUIREMENTS FOR P-245 & P-248. HOLE 48" OUTFALL																										
ASSUMED FUTURE FLOW ROUTED INTO NEW OUTFALL																										
Existing Offsite Area routed through Ex. 15" TC; Re-Routed to MH-244																										
P-Offsite	Exist Offsite	MH-244	52965	4000	56965	1.31	0.99	1.29	1.29	6.0	0.00	6.84	**8.82**	24	39	0.012	0.001294	0.0051	5.6	**17.6**	5.5	0.12	6.12	3.10	2.90	Q ok
Assumed 1/3 of Future Area 3 Routed to A St Future Trunk Line to P-261																										
P-Future A3	Addl A3	MH-261	**120000**	**0**	**120000**	2.75	1.00	2.75	2.75	6.0	0.00	6.84	**18.84**	30	98	0.012	0.001798	0.0096	8.9	**43.5**	8.6	0.19	6.19	4.20	3.26	Q ok
REMOVED 50,000SF OF A3 FROM ENTERING OUTFALL																										
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																										
P-260	DI-39	MH-261	4465	0	4465	0.10	1.00	0.10	0.10	6.0	0.00	6.84	**0.70**	15	44	0.012	0.000100	0.0032	3.2	**3.9**	2.4	0.30	6.30	3.40	3.26	Q ok
Exist Parcel Flow, Add Future A3 here																										
P-261	MH-261	MH-264	16653	1127	17780	0.41	0.99	0.40	3.26	6.0	6.30	6.75	**22.03**	36	145	0.012	0.000929	0.0030	5.6	**39.8**	5.7	0.42	6.72	3.16	2.72	Q ok
P-264	MH-264	MH-265	0	0	0	0.00	0.00	0.00	3.50	6.0	6.72	6.64	**23.23**	36	61	0.012	0.001033	0.0031	5.7	**40.3**	6.0	0.17	6.89	2.46	2.27	Q ok
P-265	MH-265	MH-245	0	0	0	0.00	0.00	0.00	3.50	6.0	6.89	6.58	**23.02**	36	*46*	0.012	0.001015	0.0037	6.2	**43.9**	6.2	0.12	7.02	2.17	2.00	Q ok
															STUB		22 LF	act length					act.	2.08		
P-262	DI-35&36	MH-264	5579	0	5579	0.13	1.00	0.13	0.13	6.0	0.00	6.84	**0.88**	15	36	0.012	0.000157	0.0031	3.2	**3.9**	2.6	0.23	6.23	3.38	3.27	Q ok
P-263	DI-37&38	MH-264	4770	0	4770	0.11	1.00	0.11	0.11	6.0	0.00	6.84	**0.75**	15	18	0.012	0.000115	0.0056	4.3	**5.2**	3.0	0.10	6.10	2.66	2.56	Q ok
Inlets Constructed in ASI																										
P-246	DI-6	MH-248	9946	0	9946	0.23	1.00	0.23	0.23	6.0	0.00	6.84	**1.56**	15	23	0.012	0.000498	0.0052	4.1	**5.1**	3.5	0.11	6.11	4.72	4.60	Q ok
P-247	DI-7	MH-248	7066	0	7066	0.16	1.00	0.16	0.16	6.0	0.00	6.84	**1.11**	15	26	0.012	0.000251	0.0046	3.9	**4.8**	3.2	0.14	6.14	4.74	4.62	Q ok
P-250	DI-8	MH-251	8718	0	8718	0.20	1.00	0.20	0.20	6.0	0.00	6.84	**1.37**	15	18	0.012	0.000383	0.0050	4.0	**4.9**	3.4	0.09	6.09	6.87	6.78	Q ok
P-251	MH-251	MH-252	0	0	0	0.00	0.00	0.00	0.33	6.0	6.09	6.81	**2.21**	15	54	0.012	0.001001	0.0078	5.0	**6.2**	4.5	0.20	6.29	6.68	6.26	Q ok
P-249	DI-9	MH-248	5442	0	5442	0.12	1.00	0.12	0.12	6.0	0.00	6.84	**0.85**	15	16	0.012	0.000149	0.0044	3.8	**4.6**	2.8	0.09	6.09	7.06	6.99	Q ok
P35	DI10	MH14	4962	681	5643	0.13	0.94	0.12	0.12	6.0	0.00	8.51	1.0	15	18	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.92	3.83	Q ok
P40	DI12	DI11	2375	125	2500	0.06	1.00	0.06	0.06	6.0	0.00	8.51	0.5	15	39	0.012	0.0000	0.005	4.0	4.9	2.4	0.27	6.27	3.67	3.47	Q ok
P37	DI11	MH15	3715	653	4368	0.10	0.92	0.09	0.15	6.0	6.27	8.40	1.3	15	18	0.012	0.0003	0.005	4.0	4.9	3.3	0.09	6.36	3.33	3.24	Q ok
	FUTURE PIPES FOR AREA 3, NOT INCLUDED IN AREA 1 SUBMITTAL																									

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 5 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: Market Street Outfall (North) | Storm Frequency: 25 -year (50-year for sumps)
4

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P33	DI24	MH13	4615	1621	6236	0.14	0.82	0.12	0.12	6.0	6.17	6.78	0.8	15	30	0.012	0.0001	0.005	4.1	5.1	2.9	0.17	6.34	4.17	4.01	Q ok
P34	MH13	MH14	1	0	1	0.00	1.00	0.00	0.12	6.0	6.34	6.75	0.8	15	44	0.012	0.0001	0.005	4.1	5.0	2.9	0.26	6.60	3.91	3.68	Q ok
P36	MH14	MH15	1	0	1	0.00	1.00	0.00	0.24	6.0	6.60	6.67	1.6	15	87	0.012	0.0005	0.005	4.1	5.0	3.5	0.42	7.01	3.57	3.12	Q ok
P-243	MH-15	MH-244	1	0	1	0.00	1.00	0.00	0.39	6.0	7.01	6.55	**2.55**	15	23	0.012	0.001331	0.0052	4.1	**5.1**	4.1	0.09	7.11	3.02	2.90	Q ok
P-244	MH-244	MH-245	1	0	1	0.00	1.00	0.00	2.03	6.0	7.11	6.52	**13.22**	24	79	0.012	0.002910	0.0089	7.3	**23.1**	7.5	0.18	7.28	2.80	2.10	Q ok
P-245	MH-245	MH-248	1	0	1	0.00	1.00	0.00	6.76	6.0	7.28	6.46	**43.68**	**36**	33	0.012	0.003654	0.0030	5.6	**39.8**	4.6	0.12	7.40	2.00	1.90	Undersizec
P-248	MH-248	MH-252	1	0	1	0.00	1.00	0.00	7.15	6.0	7.40	6.43	**45.99**	**36**	115	0.012	0.004052	0.0033	5.9	**41.5**	4.8	0.40	7.80	1.80	1.42	Undersizec
P-252	MH-252	MH-253	1	0	1	0.00	1.00	0.00	7.47	6.0	7.80	6.32	**47.22**	48	38	0.012	0.000921	0.0032	7.0	**87.4**	7.1	0.09	7.89	1.32	1.20	Q ok
P-253	MH-253	MH-254	1	0	1	0.00	1.00	0.00	7.47	6.0	7.89	6.29	**47.00**	48	102	0.012	0.000912	0.0031	6.9	**87.2**	7.1	0.24	8.13	1.10	0.78	Q ok
P-254	MH-254	OUTFALL	1	0	1	0.00	1.00	0.00	7.47	6.0	8.13	6.23	**46.57**	48	89	0.012	0.000896	0.0030	6.8	**85.7**	7.0	0.21	8.34	0.68	0.41	Q ok
P-240	DI-240	DI-241	4485	497	4982	0.11	0.96	0.11	0.11	6.0	0.00	6.84	**0.75**	15	30	0.012	0.000115	0.0050	4.0	**4.9**	2.8	0.18	6.18	3.72	3.57	Q ok
P-241	DI-241	DI-242	3403	140	3543	0.08	1.00	0.08	0.19	6.0	3.72	6.84	**1.31**	15	20	0.012	0.000349	0.0050	4.0	**4.9**	3.3	0.10	6.10	3.47	3.37	Q ok
P-242	DI-242	MH-244	6783	82	6865	0.16	1.00	0.16	0.35	6.0	3.47	6.84	**2.39**	15	12	0.012	0.001162	0.0050	4.0	**4.9**	4.0	0.05	6.05	3.27	3.21	Q ok
ASSUMES FUTURE FLOW ROUTED INTO NEW OUTFALL WILL BE CAPPED AT 48" RCP CAPACITY																										
ASSUMED FUTURE FLOW ROUTED INTO NEW OUTFALL																										
Existing Offsite Area routed through Ex. 15" TC; Re-Routed to MH-244																										
P-Offsite	Exist Offsite	MH-244	52965	4000	56965	1.31	0.99	1.29	1.29	6.0	0.00	6.84	**8.82**	18	39	0.012	0.006001	0.0051	4.6	**8.1**	3.8	0.17	6.17	3.10	2.90	Undersizec
Assumed 1/3 of Future Area 3 Routed to A St Future Trunk Line to P-261																										
P-Future A3	Addl A3	MH-261	173628	0	173628	3.99	1.00	3.99	3.99	6.0	0.00	6.84	**27.26**	30	98	0.012	0.003765	0.0096	8.9	**43.5**	9.5	0.17	6.17	4.20	3.26	Q ok
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																										
P-260	DI-39	MH-261	4465	0	4465	0.10	1.00	0.10	0.10	6.0	0.00	6.84	**0.70**	15	44	0.012	0.000100	0.0032	3.2	**3.9**	2.4	0.30	6.30	3.40	3.26	Q ok
Exist Parcel Flow, Add Future A3 here																										
P-261	MH-261	MH-264	16653	1127	17780	0.41	0.99	0.40	4.49	6.0	6.30	6.75	**30.34**	36	145	0.012	0.001763	0.0030	5.6	**39.8**	6.3	0.39	6.69	3.16	2.72	Q ok
P-264	MH-264	MH-265	0	0	0	0.00	0.00	0.00	4.73	6.0	6.69	6.64	**31.40**	36	61	0.012	0.001888	0.0031	5.7	**40.3**	6.4	0.16	6.85	2.46	2.27	Q ok
P-265	MH-265	MH-245	0	0	0	0.00	0.00	0.00	4.73	6.0	6.85	6.61	**31.26**	36	*46*	0.012	0.001872	0.0037	6.2	**43.9**	6.8	0.11	6.96	2.17	2.00	Q ok
															STUB		22 LF	act length					act.	2.08		
P-262	DI-35&36	MH-264	5579	0	5579	0.13	1.00	0.13	0.13	6.0	0.00	6.84	**0.88**	15	36	0.012	0.000157	0.0031	3.2	**3.9**	2.6	0.23	6.23	3.38	3.27	Q ok
P-263	DI-37&38	MH-264	4770	0	4770	0.11	1.00	0.11	0.11	6.0	0.00	6.84	**0.75**	15	18	0.012	0.000115	0.0056	4.3	**5.2**	3.0	0.10	6.10	2.66	2.56	Q ok
Inlets Constructed in ASI																										
P-246	DI-6	MH-248	9946	0	9946	0.23	1.00	0.23	0.23	6.0	0.00	6.84	**1.56**	15	23	0.012	0.000498	0.0052	4.1	**5.1**	3.5	0.11	6.11	4.72	4.60	Q ok
P-247	DI-7	MH-248	7066	0	7066	0.16	1.00	0.16	0.16	6.0	0.00	6.84	**1.11**	15	26	0.012	0.000251	0.0046	3.9	**4.8**	3.2	0.14	6.14	4.74	4.62	Q ok
P-250	DI-8	MH-251	8718	0	8718	0.20	1.00	0.20	0.20	6.0	0.00	6.84	**1.37**	15	18	0.012	0.000383	0.0050	4.0	**4.9**	3.4	0.09	6.09	6.87	6.78	Q ok
P-251	MH-251	MH-252	0	0	0	0.00	0.00	0.00	0.33	6.0	6.09	6.81	**2.21**	15	54	0.012	0.001001	0.0078	5.0	**6.2**	4.5	0.20	6.29	6.68	6.26	Q ok
P-249	DI-9	MH-248	5442	0	5442	0.12	1.00	0.12	0.12	6.0	0.00	6.84	**0.85**	15	16	0.012	0.000149	0.0044	3.8	**4.6**	2.8	0.09	6.09	7.06	6.99	Q ok
P35	DI10	MH14	4962	681	5643	0.13	0.94	0.12	0.12	6.0	0.00	8.51	1.0	15	18	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.92	3.83	Q ok
P40	DI12	DI11	2375	125	2500	0.06	1.00	0.06	0.06	6.0	0.00	8.51	0.5	15	39	0.012	0.0000	0.005	4.0	4.9	2.4	0.27	6.27	3.67	3.47	Q ok
P37	DI11	MH15	3715	653	4368	0.10	0.92	0.09	0.15	6.0	6.27	8.40	1.3	15	18	0.012	0.0003	0.005	4.0	4.9	3.3	0.09	6.36	3.33	3.24	Q ok
	FUTURE PIPES FOR AREA 3, NOT INCLUDED IN AREA 1 SUBMITTAL																									

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	5.78	5.78	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.78	8.36	HGL ok
P34	MH13	MH14	1.00	5.77	5.77	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	5.78	8.11	HGL ok
P36	MH14	MH15	1.00	5.71	5.71	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	5.77	7.86	HGL ok
P-243	MH-15	MH-244	1.00	5.67	5.67	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	5.71	7.17	HGL ok
P-244	MH-244	MH-245	1.60	5.34	5.34	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	5.67	7.35	HGL ok
P-245	MH-245	MH-248	2.40	5.13	5.13	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	5.34	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.68	4.68	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	5.13	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.13	4.40	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	4.68	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.77	3.98	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	4.13	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.20**	**3.61**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**3.77**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	5.75	5.75	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.75	6.85	HGL ok
P-241	DI-241	DI-242	1.00	5.73	5.73	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	5.75	6.98	HGL ok
P-242	DI-242	MH-244	1.00	5.67	5.67	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	5.73	7.07	HGL ok
P-Offsite	Exist Offsite	MH-244	1.60	5.67	5.67	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	5.75	7.07	HGL ok
P-Future A3	Addl A3	MH-261	2.00	5.71	5.71	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	5.95	7.20	HGL ok
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	5.71	5.71	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.72	6.78	HGL ok
P-261	MH-261	MH-264	2.40	5.55	5.55	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	5.71	6.80	HGL ok
P-264	MH-264	MH-265	2.40	5.44	5.44	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	5.55	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	5.34	5.34	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	5.44	6.82	HGL ok
P-262	DI-35&36	MH-264	1.00	5.55	5.55	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.56	7.04	HGL ok
P-263	DI-37&38	MH-264	1.00	5.55	5.55	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.55	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	5.13	5.60	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	5.62	8.38	HGL ok
P-247	DI-7	MH-248	1.00	5.13	5.62	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.63	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.35	7.78	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	5.75	7.26	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	7.35	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.35	7.99	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	5.77	5.77	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.77	8.11	HGL ok
P40	DI12	DI11	1.00	5.73	5.73	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.73	7.19	HGL ok
P37	DI11	MH15	1.00	5.71	5.71	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	5.73	7.09	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	5.78	5.78	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.78	8.36	HGL ok
P34	MH13	MH14	1.00	5.77	5.77	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	5.78	8.11	HGL ok
P36	MH14	MH15	1.00	5.71	5.71	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	5.77	7.86	HGL ok
P-243	MH-15	MH-244	1.00	5.67	5.67	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	5.71	7.17	HGL ok
P-244	MH-244	MH-245	1.60	5.34	5.34	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	5.67	7.35	HGL ok
P-245	MH-245	MH-248	2.40	5.13	5.13	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	5.34	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.68	4.68	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	5.13	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.13	4.40	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	4.68	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.77	3.98	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	4.13	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.40**	**3.61**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**3.77**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	5.75	5.75	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.75	6.85	HGL ok
P-241	DI-241	DI-242	1.00	5.73	5.73	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	5.75	6.98	HGL ok
P-242	DI-242	MH-244	1.00	5.67	5.67	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	5.73	7.07	HGL ok
P-Offsite	Exist Offsite	MH-244	1.60	5.67	5.67	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	5.75	7.07	HGL ok
P-Future A3	Addl A3	MH-261	2.00	5.71	5.71	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	5.95	7.20	HGL ok
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	5.71	5.71	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.72	6.78	HGL ok
P-261	MH-261	MH-264	2.40	5.55	5.55	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	5.71	6.80	HGL ok
P-264	MH-264	MH-265	2.40	5.44	5.44	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	5.55	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	5.34	5.34	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	5.44	6.82	HGL ok
P-262	DI-35&36	MH-264	1.00	5.55	5.55	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.56	7.04	HGL ok
P-263	DI-37&38	MH-264	1.00	5.55	5.55	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.55	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	5.13	5.60	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	5.62	8.38	HGL ok
P-247	DI-7	MH-248	1.00	5.13	5.62	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.63	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.35	7.78	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	5.75	7.26	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	7.35	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.35	7.99	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	5.77	5.77	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.77	8.11	HGL ok
P40	DI12	DI11	1.00	5.73	5.73	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.73	7.19	HGL ok
P37	DI11	MH15	1.00	5.71	5.71	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	5.73	7.09	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.59	8.59	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.59	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.58	8.58	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	8.59	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.52	8.52	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	8.58	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.48	8.48	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	8.52	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.15	8.15	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	8.48	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.94	7.94	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	8.15	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.49	7.49	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	7.94	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.21	7.21	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	7.49	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.06	7.06	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	7.21	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**7.06**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	8.56	8.56	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.56	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.54	8.54	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	8.56	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.48	8.48	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	8.54	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.48	8.48	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	8.56	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.52	8.52	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	8.76	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.52	8.52	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.53	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.36	8.36	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	8.52	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.25	8.25	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	8.36	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.15	8.15	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	8.25	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.36	8.36	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.37	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.36	8.36	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.36	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.94	7.94	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.95	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	7.94	7.94	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.95	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	8.65	8.65	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.66	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.56	8.56	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	8.65	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.65	8.65	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.65	10.89	HGL ok
P35	DI10	MH14	1.00	8.58	8.58	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.58	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.54	8.54	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.54	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.52	8.52	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	8.54	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.09	9.09	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.09	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.08	9.08	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	9.09	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.02	9.02	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	9.08	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.98	8.98	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.02	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.65	8.65	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	8.98	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.44	8.44	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	8.65	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.99	7.99	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	8.44	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.71	7.71	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	7.99	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.56	7.56	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	7.71	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**7.56**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	9.06	9.06	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.06	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.04	9.04	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	9.06	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.98	8.98	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	9.04	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.98	8.98	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	9.06	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.02	9.02	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	9.26	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.02	9.02	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.03	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.86	8.86	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	9.02	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.75	8.75	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	8.86	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.65	8.65	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	8.75	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.86	8.86	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.87	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.86	8.86	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.86	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.44	8.44	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.45	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.44	8.44	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.45	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.15	9.15	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.16	10.19	HGL ok
P-251	MH-251	MH-252	1.00	9.06	9.06	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	9.15	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.15	9.15	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.15	10.89	HGL ok
P35	DI10	MH14	1.00	9.08	9.08	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.08	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.04	9.04	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.04	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.02	9.02	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	9.04	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.49	9.49	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.49	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.48	9.48	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	9.49	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.42	9.42	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	9.48	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.38	9.38	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.42	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.05	9.05	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	9.38	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.84	8.84	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	9.05	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.39	8.39	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	8.84	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.11	8.11	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	8.39	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.96	7.96	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	8.11	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**7.96**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	9.46	9.46	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.46	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.44	9.44	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	9.46	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.38	9.38	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	9.44	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.38	9.38	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	9.46	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.42	9.42	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	9.66	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.42	9.42	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.43	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.26	9.26	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	9.42	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.15	9.15	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	9.26	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.05	9.05	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	9.15	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.26	9.26	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.27	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.26	9.26	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.26	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.84	8.84	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.85	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.84	8.84	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.85	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.55	9.55	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.56	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.46	9.46	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	9.55	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.55	9.55	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.55	10.89	HGL ok
P35	DI10	MH14	1.00	9.48	9.48	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.48	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.44	9.44	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.44	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.42	9.42	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	9.44	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.99	9.99	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.99	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.98	9.98	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	9.99	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.92	9.92	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	9.98	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.88	9.88	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	9.92	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.55	9.55	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	9.88	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.34	9.34	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	9.55	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.89	8.89	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	9.34	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.61	8.61	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	8.89	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	8.46	8.46	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	8.61	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**8.46**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	9.96	9.96	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.96	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.94	9.94	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	9.96	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.88	9.88	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	9.94	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.88	9.88	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	9.96	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.92	9.92	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	10.16	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.92	9.92	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.93	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.76	9.76	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	9.92	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.65	9.65	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	9.76	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.55	9.55	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	9.65	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.76	9.76	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.77	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.76	9.76	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.76	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.34	9.34	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.35	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.34	9.34	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.35	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.05	10.05	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.06	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.96	9.96	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	10.05	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.05	10.05	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.05	10.89	HGL Too High!
P35	DI10	MH14	1.00	9.98	9.98	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.98	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.94	9.94	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.94	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.92	9.92	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	9.94	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.69	10.69	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.69	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.68	10.68	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	10.69	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.62	10.62	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	10.68	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.58	10.58	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	10.62	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.25	10.25	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	10.58	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.04	10.04	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	10.25	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.59	9.59	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	10.04	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.31	9.31	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	9.59	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.16	9.16	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	9.31	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**9.16**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.66	10.66	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.66	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.64	10.64	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	10.66	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.58	10.58	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	10.64	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.58	10.58	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	10.66	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.62	10.62	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	10.86	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.62	10.62	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.63	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.46	10.46	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	10.62	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.35	10.35	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	10.46	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.25	10.25	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	10.35	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.46	10.46	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.47	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.46	10.46	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.46	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.04	10.04	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.05	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.04	10.04	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.05	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.75	10.75	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.76	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.66	10.66	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	10.75	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.75	10.75	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.75	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.68	10.68	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.68	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.64	10.64	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.64	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.62	10.62	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	10.64	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.19	11.19	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.19	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.18	11.18	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	11.19	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.12	11.12	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	11.18	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.08	11.08	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.12	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.75	10.75	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	11.08	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.54	10.54	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	10.75	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.09	10.09	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	10.54	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.81	9.81	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	10.09	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.66	9.66	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	9.81	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**9.66**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.16	11.16	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.16	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.14	11.14	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	11.16	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.08	11.08	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	11.14	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.08	11.08	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	11.16	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.12	11.12	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	11.36	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.12	11.12	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.13	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.96	10.96	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	11.12	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.85	10.85	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	10.96	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.75	10.75	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	10.85	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.96	10.96	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.97	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.96	10.96	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.96	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.54	10.54	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.55	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.54	10.54	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.55	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.25	11.25	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.26	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.16	11.16	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	11.25	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.25	11.25	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.25	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.18	11.18	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.18	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.14	11.14	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.14	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.12	11.12	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.14	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.49	12.49	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.49	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.48	12.48	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	12.49	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.42	12.42	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	12.48	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.38	12.38	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.42	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.05	12.05	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	12.38	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.84	11.84	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	12.05	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.39	11.39	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	11.84	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.11	11.11	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	11.39	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.96	10.96	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	11.11	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**10.96**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.46	12.46	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.46	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.44	12.44	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	12.46	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.38	12.38	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	12.44	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.38	12.38	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	12.46	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.42	12.42	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	12.66	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.42	12.42	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.43	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.26	12.26	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	12.42	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.15	12.15	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	12.26	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.05	12.05	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	12.15	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.26	12.26	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.27	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.26	12.26	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.26	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.84	11.84	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.85	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.84	11.84	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.85	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.55	12.55	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.56	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.46	12.46	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	12.55	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.55	12.55	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.55	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.48	12.48	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.48	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.44	12.44	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.44	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.42	12.42	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	12.44	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	7.43	7.43	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.43	8.36	HGL Too High!
P34	MH13	MH14	1.00	7.42	7.42	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	7.43	8.11	HGL Too High!
P36	MH14	MH15	1.00	7.36	7.36	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	7.42	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	7.32	7.32	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	7.36	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	6.99	6.99	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	7.32	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	6.78	6.78	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	6.99	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	6.33	6.33	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	6.78	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.05	6.05	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	6.33	9.40	HGL ok
P-253	MH-253	MH-254	3.20	5.90	5.90	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	6.05	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**5.90**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	7.40	7.40	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.40	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	7.38	7.38	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	7.40	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	7.32	7.32	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	7.38	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	7.32	7.32	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	7.40	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	7.36	7.36	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	7.60	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	7.36	7.36	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.37	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	7.20	7.20	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	7.36	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.09	7.09	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	7.20	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	6.99	6.99	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	7.09	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	7.20	7.20	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.21	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	7.20	7.20	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.20	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	6.78	6.78	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	6.79	8.38	HGL ok
P-247	DI-7	MH-248	1.00	6.78	6.78	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.79	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.49	7.78	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	7.40	7.40	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	7.49	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.49	7.99	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	7.42	7.42	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.42	8.11	HGL Too High!
P40	DI12	DI11	1.00	7.38	7.38	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.38	7.19	HGL Too High!
P37	DI11	MH15	1.00	7.36	7.36	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	7.38	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	7.63	7.63	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.63	8.36	HGL Too High!
P34	MH13	MH14	1.00	7.62	7.62	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	7.63	8.11	HGL Too High!
P36	MH14	MH15	1.00	7.56	7.56	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	7.62	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	7.52	7.52	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	7.56	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.19	7.19	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	7.52	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	6.98	6.98	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	7.19	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	6.53	6.53	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	6.98	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.25	6.25	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	6.53	9.40	HGL ok
P-253	MH-253	MH-254	3.20	6.10	6.10	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	6.25	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**6.10**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	7.60	7.60	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.60	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	7.58	7.58	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	7.60	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	7.52	7.52	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	7.58	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	7.52	7.52	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	7.60	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	7.56	7.56	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	7.80	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	7.56	7.56	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.57	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	7.40	7.40	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	7.56	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.29	7.29	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	7.40	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.19	7.19	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	7.29	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	7.40	7.40	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.41	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	7.40	7.40	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.40	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	6.98	6.98	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	6.99	8.38	HGL ok
P-247	DI-7	MH-248	1.00	6.98	6.98	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.99	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.69	7.78	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	7.60	7.60	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	7.69	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.69	7.99	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	7.62	7.62	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.62	8.11	HGL Too High!
P40	DI12	DI11	1.00	7.58	7.58	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.58	7.19	HGL Too High!
P37	DI11	MH15	1.00	7.56	7.56	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	7.58	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.13	11.13	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.13	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.12	11.12	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	11.13	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.06	11.06	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	11.12	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.02	11.02	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.06	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.69	10.69	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	11.02	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.48	10.48	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	10.69	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.03	10.03	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	10.48	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.75	9.75	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	10.03	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.60	9.60	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	9.75	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**9.60**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.10	11.10	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.10	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.08	11.08	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	11.10	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.02	11.02	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	11.08	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.02	11.02	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	11.10	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.06	11.06	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	11.30	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.06	11.06	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.07	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.90	10.90	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	11.06	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.79	10.79	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	10.90	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.69	10.69	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	10.79	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.90	10.90	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.91	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.90	10.90	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.90	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.48	10.48	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.49	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.48	10.48	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.49	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.19	11.19	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.20	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.10	11.10	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	11.19	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.19	11.19	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.19	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.12	11.12	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.12	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.08	11.08	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.08	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.06	11.06	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.08	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.63	11.63	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.63	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.62	11.62	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	11.63	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.56	11.56	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	11.62	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.52	11.52	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.56	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.19	11.19	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	11.52	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.98	10.98	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	11.19	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.53	10.53	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	10.98	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.25	10.25	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	10.53	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.10	10.10	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	10.25	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**10.10**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.60	11.60	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.60	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.58	11.58	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	11.60	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.52	11.52	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	11.58	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.52	11.52	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	11.60	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.56	11.56	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	11.80	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.56	11.56	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.57	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.40	11.40	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	11.56	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.29	11.29	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	11.40	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.19	11.19	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	11.29	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.40	11.40	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.41	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.40	11.40	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.40	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.98	10.98	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.99	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.98	10.98	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.99	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.69	11.69	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.70	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.60	11.60	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	11.69	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.69	11.69	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.69	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.62	11.62	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.62	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.58	11.58	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.58	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.56	11.56	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.58	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.03	12.03	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.03	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.02	12.02	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	12.03	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.96	11.96	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	12.02	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.92	11.92	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	11.96	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.59	11.59	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	11.92	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.38	11.38	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	11.59	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.93	10.93	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	11.38	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.65	10.65	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	10.93	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.50	10.50	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	10.65	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**10.50**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.00	12.00	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.00	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.98	11.98	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	12.00	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.92	11.92	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	11.98	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.92	11.92	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	12.00	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.96	11.96	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	12.20	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.96	11.96	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.97	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.80	11.80	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	11.96	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.69	11.69	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	11.80	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.59	11.59	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	11.69	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.80	11.80	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.81	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.80	11.80	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.80	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.38	11.38	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.39	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.38	11.38	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.39	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.09	12.09	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.10	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.00	12.00	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	12.09	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.09	12.09	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.09	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.02	12.02	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.02	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.98	11.98	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.98	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.96	11.96	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	11.98	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.53	12.53	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.53	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.52	12.52	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	12.53	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.46	12.46	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	12.52	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.42	12.42	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	12.46	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.09	12.09	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	12.42	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.88	11.88	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	12.09	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.43	11.43	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	11.88	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.15	11.15	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	11.43	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.00	11.00	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	11.15	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**11.00**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.50	12.50	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.50	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.48	12.48	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	12.50	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.42	12.42	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	12.48	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.42	12.42	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	12.50	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.46	12.46	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	12.70	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.46	12.46	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.47	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.30	12.30	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	12.46	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.19	12.19	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	12.30	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.09	12.09	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	12.19	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.30	12.30	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.31	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.30	12.30	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.30	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.88	11.88	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.89	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.88	11.88	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.89	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.59	12.59	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.60	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.50	12.50	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	12.59	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.59	12.59	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.59	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.52	12.52	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.52	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.48	12.48	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.48	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.46	12.46	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	12.48	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.23	13.23	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.23	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.22	13.22	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	13.23	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.16	13.16	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	13.22	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.12	13.12	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	13.16	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.79	12.79	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	13.12	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.58	12.58	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	12.79	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.13	12.13	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	12.58	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.85	11.85	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	12.13	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.70	11.70	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	11.85	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**11.70**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.20	13.20	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.20	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.18	13.18	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	13.20	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.12	13.12	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	13.18	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.12	13.12	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	13.20	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.16	13.16	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	13.40	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.16	13.16	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.17	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.00	13.00	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	13.16	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.89	12.89	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	13.00	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.79	12.79	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	12.89	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.00	13.00	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.01	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.00	13.00	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.00	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.58	12.58	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.59	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.58	12.58	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.59	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.29	13.29	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.30	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.20	13.20	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	13.29	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.29	13.29	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.29	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.22	13.22	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.22	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.18	13.18	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.18	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.16	13.16	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	13.18	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.73	13.73	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.73	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.72	13.72	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	13.73	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.66	13.66	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	13.72	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.62	13.62	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	13.66	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	13.29	13.29	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	13.62	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	13.08	13.08	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	13.29	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.63	12.63	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	13.08	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	12.35	12.35	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	12.63	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	12.20	12.20	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	12.35	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**12.20**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.70	13.70	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.70	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.68	13.68	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	13.70	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.62	13.62	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	13.68	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.62	13.62	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	13.70	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.66	13.66	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	13.90	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.66	13.66	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.67	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.50	13.50	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	13.66	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	13.39	13.39	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	13.50	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	13.29	13.29	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	13.39	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.50	13.50	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.51	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.50	13.50	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.50	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	13.08	13.08	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.09	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	13.08	13.08	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.09	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.79	13.79	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.80	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.70	13.70	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	13.79	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.79	13.79	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.79	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.72	13.72	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.72	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.68	13.68	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.68	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.66	13.66	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	13.68	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	15.03	15.03	15	0.8	0.7	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.03	8.36	HGL Too High!
P34	MH13	MH14	1.00	15.02	15.02	15	0.8	0.6	0	44.2	0.0001	0.01	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.0	0.5	0.00	0.01	15.03	8.11	HGL Too High!
P36	MH14	MH15	1.00	14.96	14.96	15	1.6	1.3	0	87.2	0.0005	0.05	0	0.00	0.01	0.5	0.0	0.0	0.6	0.0	0	0.00	0.01	1.3	0.5	0.01	0.05	15.02	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	14.92	14.92	15	2.6	2.1	12.7	23	0.0013	0.03	0	0.00	0.02	2.1	1.3	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	14.96	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	14.59	14.59	24	13.2	4.2	45	79	0.0029	0.23	0	0.00	0.07	5.3	4.6	24.7	2.8	0.0	90	0.09	0.20	1.0	0.5	0.10	0.33	14.92	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	14.38	14.38	36	35.7	5.1	0	33	0.0024	0.08	1	0.00	0.10	55.6	75.0	0.0	3.3	0.1	90	0.12	0.27	1.0	0.5	0.14	0.22	14.59	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	13.93	13.93	36	38.1	5.4	90	115	0.0028	0.32	2	0.00	0.11	180.5	2.0	1.0	5.1	0.1	0	0.00	0.25	1.0	0.5	0.13	0.44	14.38	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	13.65	13.65	48	39.6	3.2	90	38	0.0006	0.02	0	0.00	0.04	205.1	4.0	0.0	5.4	0.2	90	0.32	0.51	1.0	0.5	0.26	0.28	13.93	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	13.50	13.50	48	39.6	3.2	16.6	102	0.0006	0.07	0	0.00	0.04	180.5	0.0	0.0	5.1	0.1	0	0.00	0.18	1.0	0.5	0.09	0.15	13.65	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**39.1**	**3.1**	**0**	**89**	**0.0006**	**0.06**	**0**	**0.00**	**0.04**	**124.9**	**0.0**	**0.0**	**3.2**	**0.1**	**90**	**0.11**	**0.20**	**1.0**	**0.5**	**0.10**	**0.16**	**13.50**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	15.00	15.00	15	0.8	0.6	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.00	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	14.98	14.98	15	1.3	1.1	90	20	0.0003	0.01	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	1.0	0.01	0.02	15.00	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	14.92	14.92	15	2.4	1.9	90	12	0.0012	0.01	0	0.00	0.01	1.4	0.0	0.0	1.1	0.0	90	0.01	0.03	1.3	1.0	0.04	0.06	14.98	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	14.92	14.92	24	8.8	2.8	90	39	0.0013	0.05	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.08	15.00	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	14.96	14.96	30	18.8	3.8	90	98	0.0018	0.18	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.23	15.20	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	14.96	14.96	15	0.7	0.6	90	44	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.97	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	14.80	14.80	36	22.0	3.1	0	145	0.0009	0.13	0	0.00	0.04	0.4	0.0	0.0	0.6	0.0	90	0.00	0.04	1.3	0.5	0.03	0.16	14.96	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	14.69	14.69	36	23.2	3.3	0	61	0.0010	0.06	0	0.00	0.04	68.6	0.6	0.5	3.1	0.1	0	0.00	0.09	1.0	0.5	0.05	0.11	14.80	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	14.59	14.59	36	23.0	3.3	90	46	0.0010	0.05	0	0.00	0.04	76.3	0.0	0.0	3.3	0.1	0	0.00	0.10	1.0	0.5	0.05	0.10	14.69	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	14.80	14.80	15	0.9	0.7	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.81	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	14.80	14.80	15	0.7	0.6	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.80	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	14.38	14.38	15	1.6	1.3	90	23	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	14.39	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	14.38	14.38	15	1.1	0.9	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.39	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	15.09	15.09	15	1.4	1.1	85.5	18	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.10	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	15.00	15.00	15	2.2	1.8	91.5	54	0.0010	0.05	0	0.00	0.01	1.5	0.6	0.0	1.1	0.0	85.5	0.01	0.03	1.0	1.0	0.03	0.09	15.09	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	15.09	15.09	15	0.9	0.7	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.09	10.89	HGL Too High!
P35	DI10	MH14	1.00	15.02	15.02	15	1.0	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.02	8.11	HGL Too High!
P40	DI12	DI11	1.00	14.98	14.98	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.98	7.19	HGL Too High!
P37	DI11	MH15	1.00	14.96	14.96	15	1.3	1.0	90	18.4	0.0003	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	14.98	7.09	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 5 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: Market Street Outfall (North) | Storm Frequency: 50 -year (50-year for sumps)
4

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P33	DI24	MH13	4615	1621	6236	0.14	0.90	0.13	0.13	6.0	6.17	7.23	0.9	15	30	0.012	0.0002	0.005	4.1	5.1	3.1	0.16	6.33	4.17	4.01	Q ok
P34	MH13	MH14	1	0	1	0.00	1.00	0.00	0.13	6.0	6.33	7.20	0.9	15	44	0.012	0.0002	0.005	4.1	5.0	3.1	0.24	6.57	3.91	3.68	Q ok
P36	MH14	MH15	1	0	1	0.00	1.00	0.00	0.26	6.0	6.57	7.10	1.8	15	87	0.012	0.0007	0.005	4.1	5.0	3.7	0.39	6.96	3.57	3.12	Q ok
P-243	MH-15	MH-244	1	0	1	0.00	1.00	0.00	0.42	6.0	6.96	6.98	**2.90**	15	23	0.012	0.001722	0.0052	4.1	**5.1**	4.2	0.09	7.05	3.02	2.90	Q ok
P-244	MH-244	MH-245	1	0	1	0.00	1.00	0.00	2.08	6.0	7.05	6.95	**14.43**	24	79	0.012	0.003469	0.0089	7.3	**23.1**	7.9	0.17	7.22	2.80	2.10	Q ok
P-245	MH-245	MH-248	1	0	1	0.00	1.00	0.00	5.58	6.0	7.22	6.92	**38.60**	**36**	33	0.012	0.002854	0.0030	5.6	**39.8**	6.5	0.08	7.30	2.00	1.90	Q ok
P-248	MH-248	MH-252	1	0	1	0.00	1.00	0.00	5.97	6.0	7.30	6.89	**41.12**	**36**	115	0.012	0.003239	0.0033	5.9	**41.5**	6.9	0.28	7.58	1.80	1.42	Q ok
P-252	MH-252	MH-253	1	0	1	0.00	1.00	0.00	6.30	6.0	7.58	6.79	**42.77**	48	38	0.012	0.000756	0.0032	7.0	**87.4**	6.9	0.09	7.68	1.32	1.20	Q ok
P-253	MH-253	MH-254	1	0	1	0.00	1.00	0.00	6.30	6.0	7.68	6.76	**42.58**	48	102	0.012	0.000749	0.0031	6.9	**87.2**	6.9	0.25	7.92	1.10	0.78	Q ok
P-254	MH-254	OUTFALL	1	0	1	0.00	1.00	0.00	6.30	6.0	7.92	6.70	**42.19**	48	89	0.012	0.000735	0.0030	6.8	**85.7**	6.8	0.22	8.14	0.68	0.41	Q ok
P-240	DI-240	DI-241	4485	497	4982	0.11	1.00	0.11	0.11	6.0	0.00	7.29	**0.83**	15	30	0.012	0.000142	0.0050	4.0	**4.9**	2.8	0.18	6.18	3.72	3.57	Q ok
P-241	DI-241	DI-242	3403	140	3543	0.08	1.00	0.08	0.20	6.0	3.72	7.29	**1.43**	15	20	0.012	0.000416	0.0050	4.0	**4.9**	3.4	0.10	6.10	3.47	3.37	Q ok
P-242	DI-242	MH-244	6783	82	6865	0.16	1.00	0.16	0.35	6.0	3.47	7.29	**2.58**	15	12	0.012	0.001355	0.0050	4.0	**4.9**	4.0	0.05	6.05	3.27	3.21	Q ok
LIMIT FUTURE FLOW FROM A3 TO MACTH 36" PIPE CAPACITY TO MEET CLEARANCE/COVER REQUIREMENTS FOR P-245 & P-248. HOLE 48" OUTFALL																										
ASSUMED FUTURE FLOW ROUTED INTO NEW OUTFALL																										
Existing Offsite Area routed through Ex. 15" TC; Re-Routed to MH-244																										
P-Offsite	Exist Offsite	MH-244	52965	4000	56965	1.31	1.00	1.31	1.31	6.0	0.00	7.29	**9.53**	24	39	0.012	0.001513	0.0051	5.6	**17.6**	5.7	0.11	6.11	3.10	2.90	Q ok
Assumed 1/3 of Future Area 3 Routed to A St Future Trunk Line to P-261																										
P-Future A3	Addl A3	MH-261	**120000**	**0**	**120000**	2.75	1.00	2.75	2.75	6.0	0.00	7.29	**20.08**	30	98	0.012	0.002043	0.0096	8.9	**43.5**	8.6	0.19	6.19	4.20	3.26	Q ok
REMOVED 50,000SF OF A3 FROM ENTERING OUTFALL																										
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																										
P-260	DI-39	MH-261	4465	0	4465	0.10	1.00	0.10	0.10	6.0	0.00	7.29	**0.75**	15	44	0.012	0.000114	0.0032	3.2	**3.9**	2.4	0.30	6.30	3.40	3.26	Q ok
Exist Parcel Flow, Add Future A3 here																										
P-261	MH-261	MH-264	16653	1127	17780	0.41	1.00	0.41	3.27	6.0	6.30	7.20	**23.50**	36	145	0.012	0.001058	0.0030	5.6	**39.8**	5.9	0.41	6.71	3.16	2.72	Q ok
P-264	MH-264	MH-265	0	0	0	0.00	0.00	0.00	3.50	6.0	6.71	7.07	**24.78**	36	61	0.012	0.001176	0.0031	5.7	**40.3**	6.0	0.17	6.88	2.46	2.27	Q ok
P-265	MH-265	MH-245	0	0	0	0.00	0.00	0.00	3.50	6.0	6.88	7.01	**24.56**	36	*46*	0.012	0.001155	0.0037	6.2	**43.9**	6.3	0.12	7.00	2.17	2.00	Q ok
															STUB		22 LF	act length					act.	2.08		
P-262	DI-35&36	MH-264	5579	0	5579	0.13	1.00	0.13	0.13	6.0	0.00	7.29	**0.93**	15	36	0.012	0.000178	0.0031	3.2	**3.9**	2.6	0.23	6.23	3.38	3.27	Q ok
P-263	DI-37&38	MH-264	4770	0	4770	0.11	1.00	0.11	0.11	6.0	0.00	7.29	**0.80**	15	18	0.012	0.000130	0.0056	4.3	**5.2**	3.0	0.10	6.10	2.66	2.56	Q ok
Inlets Constructed in ASI																										
P-246	DI-6	MH-248	9946	0	9946	0.23	1.00	0.23	0.23	6.0	0.00	7.29	**1.66**	15	23	0.012	0.000566	0.0052	4.1	**5.1**	3.7	0.10	6.10	4.72	4.60	Q ok
P-247	DI-7	MH-248	7066	0	7066	0.16	1.00	0.16	0.16	6.0	0.00	7.29	**1.18**	15	26	0.012	0.000286	0.0046	3.9	**4.8**	3.2	0.14	6.14	4.74	4.62	Q ok
P-250	DI-8	MH-251	8718	0	8718	0.20	1.00	0.20	0.20	6.0	0.00	7.29	**1.46**	15	18	0.012	0.000435	0.0050	4.0	**4.9**	3.4	0.09	6.09	6.87	6.78	Q ok
P-251	MH-251	MH-252	0	0	0	0.00	0.00	0.00	0.33	6.0	6.09	7.26	**2.36**	15	54	0.012	0.001137	0.0078	5.0	**6.2**	4.6	0.19	6.29	6.68	6.26	Q ok
P-249	DI-9	MH-248	5442	0	5442	0.12	1.00	0.12	0.12	6.0	0.00	7.29	**0.91**	15	16	0.012	0.000169	0.0044	3.8	**4.6**	2.8	0.09	6.09	7.06	6.99	Q ok
P35	DI10	MH14	4962	681	5643	0.13	1.00	0.13	0.13	6.0	0.00	8.51	1.1	15	18	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.92	3.83	Q ok
P40	DI12	DI11	2375	125	2500	0.06	1.00	0.06	0.06	6.0	0.00	8.51	0.5	15	39	0.012	0.0000	0.005	4.0	4.9	2.4	0.27	6.27	3.67	3.47	Q ok
P37	DI11	MH15	3715	653	4368	0.10	1.00	0.10	0.16	6.0	6.27	8.40	1.3	15	18	0.012	0.0004	0.005	4.0	4.9	3.3	0.09	6.36	3.33	3.24	Q ok
	FUTURE PIPES FOR AREA 3, NOT INCLUDED IN AREA 1 SUBMITTAL																									

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.02	6.02	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.03	8.36	HGL ok
P34	MH13	MH14	1.00	6.01	6.01	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	6.02	8.11	HGL ok
P36	MH14	MH15	1.00	5.94	5.94	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	6.01	7.86	HGL ok
P-243	MH-15	MH-244	1.00	5.89	5.89	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	5.94	7.17	HGL ok
P-244	MH-244	MH-245	1.60	5.50	5.50	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	5.89	7.35	HGL ok
P-245	MH-245	MH-248	2.40	5.25	5.25	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	5.50	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.73	4.73	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	5.25	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.16	4.40	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	4.73	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.79	3.98	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	4.16	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.20**	**3.61**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**3.79**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	5.98	5.98	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.98	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	5.95	5.95	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	5.98	6.98	HGL ok
P-242	DI-242	MH-244	1.00	5.89	5.89	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	5.95	7.07	HGL ok
P-Offsite	Exist Offsite	MH-244	1.60	5.89	5.89	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	5.98	7.07	HGL ok
P-Future A3	Addl A3	MH-261	2.00	5.92	5.92	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	6.18	7.20	HGL ok
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	5.92	5.92	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.92	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	5.73	5.73	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	5.92	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	5.61	5.61	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	5.73	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	5.50	5.50	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	5.61	6.82	HGL ok
P-262	DI-35&36	MH-264	1.00	5.73	5.73	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.74	7.04	HGL ok
P-263	DI-37&38	MH-264	1.00	5.73	5.73	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.74	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	5.25	5.60	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	5.62	8.38	HGL ok
P-247	DI-7	MH-248	1.00	5.25	5.62	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.63	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.36	7.78	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	5.98	7.26	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	7.36	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.36	7.99	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	6.01	6.01	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.02	8.11	HGL ok
P40	DI12	DI11	1.00	5.96	5.96	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.96	7.19	HGL ok
P37	DI11	MH15	1.00	5.94	5.94	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	5.96	7.09	HGL ok

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Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.02	6.02	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.03	8.36	HGL ok
P34	MH13	MH14	1.00	6.01	6.01	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	6.02	8.11	HGL ok
P36	MH14	MH15	1.00	5.94	5.94	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	6.01	7.86	HGL ok
P-243	MH-15	MH-244	1.00	5.89	5.89	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	5.94	7.17	HGL ok
P-244	MH-244	MH-245	1.60	5.50	5.50	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	5.89	7.35	HGL ok
P-245	MH-245	MH-248	2.40	5.25	5.25	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	5.50	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.73	4.73	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	5.25	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.16	4.40	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	4.73	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.79	3.98	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	4.16	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.40**	**3.61**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**3.79**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	5.98	5.98	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.98	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	5.95	5.95	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	5.98	6.98	HGL ok
P-242	DI-242	MH-244	1.00	5.89	5.89	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	5.95	7.07	HGL ok
P-Offsite	Exist Offsite	MH-244	1.60	5.89	5.89	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	5.98	7.07	HGL ok
P-Future A3	Addl A3	MH-261	2.00	5.92	5.92	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	6.18	7.20	HGL ok
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	5.92	5.92	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.92	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	5.73	5.73	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	5.92	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	5.61	5.61	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	5.73	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	5.50	5.50	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	5.61	6.82	HGL ok
P-262	DI-35&36	MH-264	1.00	5.73	5.73	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.74	7.04	HGL ok
P-263	DI-37&38	MH-264	1.00	5.73	5.73	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.74	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	5.25	5.60	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	5.62	8.38	HGL ok
P-247	DI-7	MH-248	1.00	5.25	5.62	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.63	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.36	7.78	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	5.98	7.26	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	7.36	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.36	7.99	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	6.01	6.01	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.02	8.11	HGL ok
P40	DI12	DI11	1.00	5.96	5.96	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.96	7.19	HGL ok
P37	DI11	MH15	1.00	5.94	5.94	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	5.96	7.09	HGL ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.89	8.89	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.89	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.87	8.87	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	8.89	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.80	8.80	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	8.87	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.75	8.75	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	8.80	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.36	8.36	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	8.75	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.11	8.11	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	8.36	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.59	7.59	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	8.11	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.26	7.26	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	7.59	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.08	7.08	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	7.26	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**7.08**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	8.84	8.84	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.85	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.82	8.82	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	8.84	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.75	8.75	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	8.82	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.75	8.75	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	8.84	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.78	8.78	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	9.04	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.78	8.78	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.79	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.59	8.59	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	8.78	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.47	8.47	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	8.59	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.36	8.36	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	8.47	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.59	8.59	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.60	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.59	8.59	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.60	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.11	8.11	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.13	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.11	8.11	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.12	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	8.94	8.94	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	8.96	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.85	8.85	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	8.94	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.94	8.94	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.95	10.89	HGL ok
P35	DI10	MH14	1.00	8.87	8.87	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.88	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.82	8.82	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.82	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.80	8.80	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	8.82	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.39	9.39	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.39	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.37	9.37	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	9.39	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.30	9.30	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	9.37	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.25	9.25	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	9.30	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.86	8.86	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	9.25	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.61	8.61	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	8.86	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.09	8.09	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	8.61	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.76	7.76	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	8.09	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.58	7.58	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	7.76	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**7.58**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	9.34	9.34	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.35	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.32	9.32	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	9.34	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.25	9.25	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	9.32	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.25	9.25	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	9.34	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.28	9.28	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	9.54	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.28	9.28	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.29	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.09	9.09	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	9.28	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.97	8.97	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	9.09	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.86	8.86	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	8.97	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.09	9.09	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.10	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.09	9.09	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.10	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.61	8.61	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.63	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.61	8.61	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.62	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.44	9.44	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	9.46	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.35	9.35	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	9.44	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.44	9.44	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.45	10.89	HGL ok
P35	DI10	MH14	1.00	9.37	9.37	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.38	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.32	9.32	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.32	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.30	9.30	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	9.32	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.79	9.79	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.79	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.77	9.77	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	9.79	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.70	9.70	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	9.77	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.65	9.65	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	9.70	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.26	9.26	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	9.65	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.01	9.01	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	9.26	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.49	8.49	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	9.01	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.16	8.16	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	8.49	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	7.98	7.98	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	8.16	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**7.98**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	9.74	9.74	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.75	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.72	9.72	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	9.74	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.65	9.65	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	9.72	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.65	9.65	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	9.74	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.68	9.68	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	9.94	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.68	9.68	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.69	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.49	9.49	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	9.68	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.37	9.37	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	9.49	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.26	9.26	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	9.37	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.49	9.49	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.50	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.49	9.49	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.50	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.01	9.01	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.03	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.01	9.01	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.02	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.84	9.84	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	9.86	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.75	9.75	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	9.84	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.84	9.84	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.85	10.89	HGL ok
P35	DI10	MH14	1.00	9.77	9.77	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.78	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.72	9.72	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.72	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.70	9.70	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	9.72	7.09	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location No.	From	To	Minimum Starting Depth, (dc+D)/2 or 0.8D (0.8D, ft)	Tailwater, ltlnk to Inlet WSE of downstream pipe (TW, ft)	Outlet W. S. Elevation (HGL Dn, ft)	Outflow Pipe Diameter (D_o, in)	Outflow Pipe Design Flow (Q_o, cfs)	Pressure-flow Vel. $V_o=Q_o/A$ (V_o, fps)	Skew angle vs. (Δ_o, deg)	Outflow Pipe Length (L, ft)	Friction Slope (S_{fo}, ft/ft)	Friction Loss (H_f, ft)	Angle of Curvature (O, deg)	Curved align.: add Hc = 0.002*O*V_o^2/2g (H_c, ft)	Contraction Loss (H_o, ft)	Q*V for determining controlling inflow pipe (Q1V1, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q2V2, ft^4/s^2)	Q*V for determining controlling inflow pipe (Q3V3, ft^4/s^2)	Controlling Inflow Velocity (Vi)	Expansion Loss (Hi, ft)	Controlling In-flow skew (Δ_i, deg)	Bend Loss (H_Δ, ft)	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$ (H_t, cfs)	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss ($H_{t\,adj}$, ft)	Tot. H Loss, $H = H_f + H_{t\,adj}$ (H, ft)	Inlet W. S. Elevation (HGL Up, ft)	Top of Grate (T/G, ft)	HGL Check
P33	DI24	MH13	1.00	10.99	10.99	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.99	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.97	10.97	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	10.99	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.90	10.90	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	10.97	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.85	10.85	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	10.90	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.46	10.46	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	10.85	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.21	10.21	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	10.46	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.69	9.69	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	10.21	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.36	9.36	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	9.69	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.18	9.18	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	9.36	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**9.18**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.94	10.94	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.95	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.92	10.92	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	10.94	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.85	10.85	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	10.92	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.85	10.85	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	10.94	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.88	10.88	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	11.14	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.88	10.88	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.89	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.69	10.69	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	10.88	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.57	10.57	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	10.69	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.46	10.46	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	10.57	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.69	10.69	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.70	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.69	10.69	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.70	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.21	10.21	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.23	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.21	10.21	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.22	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.04	11.04	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	11.06	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.95	10.95	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	11.04	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.04	11.04	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.05	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.97	10.97	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.98	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.92	10.92	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.92	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.90	10.90	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	10.92	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.70	9.70	15	0.5	0.4	90	30.4	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.71	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.70	9.70	15	0.5	0.4	0	44.2	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.0	0.5	0.00	0.00	9.70	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.68	9.68	15	1.0	0.8	0	87.2	0.0002	0.02	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	0.5	0.00	0.02	9.70	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.66	9.66	15	1.6	1.3	12.7	23	0.0005	0.01	0	0.00	0.01	0.8	1.1	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	9.68	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.53	9.53	24	8.3	2.7	45	79	0.0012	0.09	0	0.00	0.03	2.1	1.9	9.9	1.8	0.0	90	0.03	0.08	1.0	0.5	0.04	0.13	9.66	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.44	9.44	36	23.2	3.3	0	33	0.0010	0.03	1	0.00	0.04	22.1	32.0	0.0	2.1	0.0	90	0.05	0.12	1.0	0.5	0.06	0.09	9.53	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.25	9.25	36	24.7	3.5	90	115	0.0012	0.13	2	0.00	0.05	75.9	0.9	0.4	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.19	9.44	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.13	9.13	48	25.6	2.0	90	38	0.0003	0.01	0	0.00	0.02	86.4	1.8	0.0	3.5	0.1	90	0.13	0.22	1.0	0.5	0.11	0.12	9.25	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.07	9.07	48	25.5	2.0	16.6	102	0.0003	0.03	0	0.00	0.02	75.9	0.0	0.0	3.3	0.1	0	0.00	0.07	1.0	0.5	0.04	0.06	9.13	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**25.3**	**2.0**	**0**	**89**	**0.0003**	**0.02**	**0**	**0.00**	**0.02**	**52.3**	**0.0**	**0.0**	**2.0**	**0.0**	**90**	**0.05**	**0.08**	**1.0**	**0.5**	**0.04**	**0.07**	**9.07**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	9.69	9.69	15	0.5	0.4	90	30	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.69	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.68	9.68	15	0.8	0.7	90	20	0.0001	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	1.0	0.01	0.01	9.69	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.66	9.66	15	1.5	1.3	90	12	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	9.68	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.66	9.66	24	5.6	1.8	90	39	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	9.69	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.69	9.69	30	12.5	2.5	90	98	0.0008	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.10	9.79	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.69	9.69	15	0.5	0.4	90	44	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.69	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.62	9.62	36	14.5	2.0	0	145	0.0004	0.06	0	0.00	0.02	0.2	0.0	0.0	0.4	0.0	90	0.00	0.02	1.3	0.5	0.01	0.07	9.69	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.57	9.57	36	15.2	2.1	0	61	0.0004	0.03	0	0.00	0.02	29.6	0.3	0.2	2.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	9.62	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.53	9.53	36	15.1	2.1	90	46	0.0004	0.02	0	0.00	0.02	32.6	0.0	0.0	2.1	0.0	0	0.00	0.04	1.0	0.5	0.02	0.04	9.57	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.62	9.62	15	0.6	0.5	90	36	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.62	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.62	9.62	15	0.5	0.4	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.62	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.44	9.44	15	1.0	0.8	90	23	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.44	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.44	9.44	15	0.7	0.6	90	26	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.44	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.73	9.73	15	0.9	0.7	85.5	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.73	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.69	9.69	15	1.5	1.2	91.5	54	0.0004	0.02	0	0.00	0.01	0.7	0.3	0.0	0.7	0.0	85.5	0.01	0.01	1.0	1.0	0.01	0.04	9.73	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.73	9.73	15	0.6	0.5	93.9	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.73	10.89	HGL ok
P35	DI10	MH14	1.00	9.70	9.70	15	0.9	0.8	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.71	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.69	9.69	15	0.4	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.69	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.68	9.68	15	1.1	0.9	90	18.4	0.0003	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.00	1.3	1.0	0.01	0.01	9.69	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.49	11.49	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.49	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.47	11.47	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	11.49	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.40	11.40	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	11.47	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.35	11.35	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	11.40	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.96	10.96	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	11.35	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.71	10.71	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	10.96	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.19	10.19	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	10.71	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.86	9.86	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	10.19	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.68	9.68	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	9.86	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**9.68**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.44	11.44	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.45	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.42	11.42	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	11.44	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.35	11.35	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	11.42	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.35	11.35	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	11.44	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.38	11.38	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	11.64	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.38	11.38	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.39	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.19	11.19	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	11.38	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.07	11.07	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	11.19	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.96	10.96	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	11.07	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.19	11.19	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.20	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.19	11.19	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.20	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.71	10.71	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.73	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.71	10.71	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.72	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.54	11.54	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	11.56	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.45	11.45	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	11.54	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.54	11.54	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.55	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.47	11.47	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.48	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.42	11.42	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.42	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.40	11.40	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	11.42	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.79	12.79	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.79	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.77	12.77	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	12.79	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.70	12.70	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	12.77	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.65	12.65	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	12.70	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.26	12.26	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	12.65	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.01	12.01	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	12.26	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.49	11.49	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	12.01	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.16	11.16	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	11.49	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.98	10.98	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	11.16	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**10.98**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.74	12.74	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.75	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.72	12.72	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	12.74	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.65	12.65	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	12.72	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.65	12.65	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	12.74	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.68	12.68	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	12.94	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.68	12.68	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.69	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.49	12.49	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	12.68	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.37	12.37	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	12.49	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.26	12.26	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	12.37	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.49	12.49	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.50	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.49	12.49	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.50	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.01	12.01	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.03	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.01	12.01	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.02	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.84	12.84	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.86	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.75	12.75	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	12.84	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.84	12.84	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.85	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.77	12.77	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.78	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.72	12.72	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.72	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.70	12.70	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	12.72	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5	
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077	
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)				

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	7.73	7.73	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.73	8.36	HGL Too High!
P34	MH13	MH14	1.00	7.71	7.71	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	7.73	8.11	HGL Too High!
P36	MH14	MH15	1.00	7.64	7.64	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	7.71	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	7.59	7.59	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	7.64	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.20	7.20	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	7.59	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	6.95	6.95	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	7.20	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	6.43	6.43	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	6.95	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.10	6.10	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	6.43	9.40	HGL ok
P-253	MH-253	MH-254	3.20	5.92	5.92	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	6.10	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**5.92**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	7.68	7.68	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.69	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	7.66	7.66	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	7.68	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	7.59	7.59	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	7.66	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	7.59	7.59	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	7.68	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	7.62	7.62	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	7.88	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	7.62	7.62	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.63	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	7.43	7.43	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	7.62	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.31	7.31	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	7.43	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.20	7.20	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	7.31	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	7.43	7.43	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.44	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	7.43	7.43	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.44	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	6.95	6.95	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	6.97	8.38	HGL ok
P-247	DI-7	MH-248	1.00	6.95	6.95	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.96	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.78	7.78	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	7.80	10.19	HGL ok
P-251	MH-251	MH-252	1.00	7.69	7.69	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	7.78	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.78	7.99	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	7.71	7.71	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.72	8.11	HGL Too High!
P40	DI12	DI11	1.00	7.66	7.66	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.66	7.19	HGL Too High!
P37	DI11	MH15	1.00	7.64	7.64	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	7.66	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	7.93	7.93	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.93	8.36	HGL Too High!
P34	MH13	MH14	1.00	7.91	7.91	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	7.93	8.11	HGL Too High!
P36	MH14	MH15	1.00	7.84	7.84	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	7.91	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	7.79	7.79	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	7.84	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.40	7.40	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	7.79	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.15	7.15	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	7.40	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	6.63	6.63	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	7.15	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.30	6.30	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	6.63	9.40	HGL ok
P-253	MH-253	MH-254	3.20	6.12	6.12	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	6.30	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**6.12**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	7.88	7.88	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.89	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	7.86	7.86	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	7.88	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	7.79	7.79	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	7.86	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	7.79	7.79	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	7.88	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	7.82	7.82	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	8.08	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	7.82	7.82	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.83	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	7.63	7.63	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	7.82	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.51	7.51	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	7.63	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.40	7.40	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	7.51	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	7.63	7.63	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.64	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	7.63	7.63	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.64	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.15	7.15	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.17	8.38	HGL ok
P-247	DI-7	MH-248	1.00	7.15	7.15	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.16	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.98	7.98	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	8.00	10.19	HGL ok
P-251	MH-251	MH-252	1.00	7.89	7.89	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	7.98	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.98	7.99	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.99	10.89	HGL ok
P35	DI10	MH14	1.00	7.91	7.91	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.92	8.11	HGL Too High!
P40	DI12	DI11	1.00	7.86	7.86	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.86	7.19	HGL Too High!
P37	DI11	MH15	1.00	7.84	7.84	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	7.86	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.43	11.43	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.43	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.41	11.41	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	11.43	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.34	11.34	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	11.41	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.29	11.29	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	11.34	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.90	10.90	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	11.29	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.65	10.65	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	10.90	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.13	10.13	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	10.65	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.80	9.80	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	10.13	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.62	9.62	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	9.80	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**9.62**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.38	11.38	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.39	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.36	11.36	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	11.38	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.29	11.29	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	11.36	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.29	11.29	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	11.38	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.32	11.32	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	11.58	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.32	11.32	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.33	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.13	11.13	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	11.32	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.01	11.01	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	11.13	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.90	10.90	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	11.01	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.13	11.13	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.14	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.13	11.13	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.14	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.65	10.65	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.67	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.65	10.65	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.66	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.48	11.48	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	11.50	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.39	11.39	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	11.48	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.48	11.48	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.49	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.41	11.41	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.42	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.36	11.36	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.36	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.34	11.34	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	11.36	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.93	11.93	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.93	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.91	11.91	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	11.93	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.84	11.84	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	11.91	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.79	11.79	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	11.84	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.40	11.40	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	11.79	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.15	11.15	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	11.40	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.63	10.63	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	11.15	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.30	10.30	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	10.63	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.12	10.12	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	10.30	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**10.12**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.88	11.88	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.89	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.86	11.86	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	11.88	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.79	11.79	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	11.86	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.79	11.79	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	11.88	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.82	11.82	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	12.08	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.82	11.82	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.83	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.63	11.63	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	11.82	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.51	11.51	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	11.63	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.40	11.40	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	11.51	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.63	11.63	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.64	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.63	11.63	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.64	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.15	11.15	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.17	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.15	11.15	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.16	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.98	11.98	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.00	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.89	11.89	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	11.98	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.98	11.98	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.99	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.91	11.91	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.92	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.86	11.86	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.86	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.84	11.84	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	11.86	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.33	12.33	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.33	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.31	12.31	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	12.33	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.24	12.24	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	12.31	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.19	12.19	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	12.24	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.80	11.80	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	12.19	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.55	11.55	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	11.80	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.03	11.03	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	11.55	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.70	10.70	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	11.03	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.52	10.52	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	10.70	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**10.52**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.28	12.28	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.29	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.26	12.26	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	12.28	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.19	12.19	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	12.26	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.19	12.19	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	12.28	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.22	12.22	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	12.48	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.22	12.22	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.23	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.03	12.03	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	12.22	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.91	11.91	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	12.03	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.80	11.80	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	11.91	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.03	12.03	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.04	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.03	12.03	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.04	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.55	11.55	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.57	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.55	11.55	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.56	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.38	12.38	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.40	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.29	12.29	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	12.38	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.38	12.38	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.39	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.31	12.31	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.32	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.26	12.26	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.26	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.24	12.24	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	12.26	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.83	12.83	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.83	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.81	12.81	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	12.83	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.74	12.74	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	12.81	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.69	12.69	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	12.74	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.30	12.30	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	12.69	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.05	12.05	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	12.30	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.53	11.53	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	12.05	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.20	11.20	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	11.53	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.02	11.02	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	11.20	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**11.02**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.78	12.78	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.79	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.76	12.76	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	12.78	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.69	12.69	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	12.76	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.69	12.69	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	12.78	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.72	12.72	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	12.98	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.72	12.72	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.73	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.53	12.53	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	12.72	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.41	12.41	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	12.53	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.30	12.30	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	12.41	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.53	12.53	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.54	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.53	12.53	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.54	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.05	12.05	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.07	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.05	12.05	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.06	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.88	12.88	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.90	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.79	12.79	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	12.88	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.88	12.88	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.89	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.81	12.81	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.82	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.76	12.76	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.76	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.74	12.74	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	12.76	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.53	13.53	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.53	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.51	13.51	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	13.53	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.44	13.44	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	13.51	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.39	13.39	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	13.44	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	13.00	13.00	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	13.39	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.75	12.75	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	13.00	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.23	12.23	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	12.75	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.90	11.90	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	12.23	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.72	11.72	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	11.90	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**11.72**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.48	13.48	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.49	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.46	13.46	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	13.48	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.39	13.39	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	13.46	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.39	13.39	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	13.48	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.42	13.42	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	13.68	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.42	13.42	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.43	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.23	13.23	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	13.42	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	13.11	13.11	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	13.23	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	13.00	13.00	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	13.11	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.23	13.23	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.24	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.23	13.23	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.24	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.75	12.75	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.77	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.75	12.75	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.76	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.58	13.58	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	13.60	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.49	13.49	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	13.58	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.58	13.58	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.59	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.51	13.51	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.52	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.46	13.46	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.46	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.44	13.44	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	13.46	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	14.03	14.03	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.03	8.36	HGL Too High!
P34	MH13	MH14	1.00	14.01	14.01	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	14.03	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.94	13.94	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	14.01	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.89	13.89	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	13.94	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	13.50	13.50	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	13.89	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	13.25	13.25	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	13.50	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.73	12.73	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	13.25	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	12.40	12.40	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	12.73	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	12.22	12.22	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	12.40	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**12.22**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.98	13.98	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.99	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.96	13.96	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	13.98	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.89	13.89	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	13.96	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.89	13.89	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	13.98	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.92	13.92	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	14.18	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.92	13.92	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.93	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.73	13.73	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	13.92	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	13.61	13.61	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	13.73	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	13.50	13.50	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	13.61	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.73	13.73	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.74	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.73	13.73	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.74	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	13.25	13.25	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.27	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	13.25	13.25	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.26	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	14.08	14.08	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	14.10	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.99	13.99	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	14.08	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	14.08	14.08	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.09	10.89	HGL Too High!
P35	DI10	MH14	1.00	14.01	14.01	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.02	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.96	13.96	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.96	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.94	13.94	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	13.96	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignt.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	15.33	15.33	15	0.9	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.33	8.36	HGL Too High!
P34	MH13	MH14	1.00	15.31	15.31	15	0.9	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.7	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.01	15.33	8.11	HGL Too High!
P36	MH14	MH15	1.00	15.24	15.24	15	1.8	1.5	0	87.2	0.0007	0.06	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.07	15.31	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	15.19	15.19	15	2.9	2.4	12.7	23	0.0017	0.04	0	0.00	0.02	2.7	1.4	0.0	1.5	0.0	0	0.00	0.03	1.0	0.5	0.02	0.06	15.24	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	14.80	14.80	24	14.4	4.6	45	79	0.0035	0.27	0	0.00	0.08	6.9	5.4	28.9	3.0	0.1	90	0.10	0.23	1.0	0.5	0.12	0.39	15.19	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	14.55	14.55	36	38.6	5.5	0	33	0.0029	0.09	1	0.00	0.12	66.3	85.3	0.0	3.5	0.1	90	0.13	0.31	1.0	0.5	0.16	0.25	14.80	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	14.03	14.03	36	41.1	5.8	90	115	0.0032	0.37	2	0.00	0.13	210.8	2.3	1.1	5.5	0.2	0	0.00	0.29	1.0	0.5	0.15	0.52	14.55	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	13.70	13.70	48	42.8	3.4	90	38	0.0008	0.03	0	0.00	0.04	239.2	4.5	0.0	5.8	0.2	90	0.37	0.60	1.0	0.5	0.30	0.33	14.03	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	13.52	13.52	48	42.6	3.4	16.6	102	0.0007	0.08	0	0.00	0.04	210.8	0.0	0.0	5.5	0.2	0	0.00	0.21	1.0	0.5	0.10	0.18	13.70	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**42.2**	**3.4**	**0**	**89**	**0.0007**	**0.07**	**0**	**0.00**	**0.04**	**145.6**	**0.0**	**0.0**	**3.4**	**0.1**	**90**	**0.13**	**0.23**	**1.0**	**0.5**	**0.12**	**0.18**	**13.52**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	15.28	15.28	15	0.8	0.7	90	30	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.29	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	15.26	15.26	15	1.4	1.2	90	20	0.0004	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.02	15.28	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	15.19	15.19	15	2.6	2.1	90	12	0.0014	0.02	0	0.00	0.02	1.7	0.0	0.0	1.2	0.0	90	0.01	0.04	1.3	1.0	0.05	0.07	15.26	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	15.19	15.19	24	9.5	3.0	90	39	0.0015	0.06	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.09	15.28	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	15.22	15.22	30	20.1	4.1	90	98	0.0020	0.20	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.27	15.48	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	15.22	15.22	15	0.7	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.23	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	15.03	15.03	36	23.5	3.3	0	145	0.0011	0.15	0	0.00	0.04	0.5	0.0	0.0	0.6	0.0	90	0.00	0.05	1.3	0.5	0.03	0.19	15.22	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	14.91	14.91	36	24.8	3.5	0	61	0.0012	0.07	0	0.00	0.05	78.1	0.7	0.5	3.3	0.1	0	0.00	0.11	1.0	0.5	0.05	0.13	15.03	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	14.80	14.80	36	24.6	3.5	90	46	0.0012	0.05	0	0.00	0.05	86.9	0.0	0.0	3.5	0.1	0	0.00	0.11	1.0	0.5	0.06	0.11	14.91	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	15.03	15.03	15	0.9	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.04	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	15.03	15.03	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.04	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	14.55	14.55	15	1.7	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	14.57	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	14.55	14.55	15	1.2	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.56	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	15.38	15.38	15	1.5	1.2	85.5	18	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	15.40	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	15.29	15.29	15	2.4	1.9	91.5	54	0.0011	0.06	0	0.00	0.01	1.7	0.7	0.0	1.2	0.0	85.5	0.01	0.04	1.0	1.0	0.04	0.10	15.38	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	15.38	15.38	15	0.9	0.7	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.39	10.89	HGL Too High!
P35	DI10	MH14	1.00	15.31	15.31	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.32	8.11	HGL Too High!
P40	DI12	DI11	1.00	15.26	15.26	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.26	7.19	HGL Too High!
P37	DI11	MH15	1.00	15.24	15.24	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	15.26	7.09	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 5 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: Market Street Outfall (North) | Storm Frequency: 100 -year (50-year for sumps)
4

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P33	DI24	MH13	4615	1621	6236	0.14	0.94	0.13	0.13	6.0	6.17	7.66	1.0	15	30	0.012	0.0002	0.005	4.1	5.1	3.1	0.16	6.33	4.17	4.01	Q ok
P34	MH13	MH14	1	0	1	0.00	1.00	0.00	0.13	6.0	6.33	7.63	1.0	15	44	0.012	0.0002	0.005	4.1	5.0	3.1	0.24	6.57	3.91	3.68	Q ok
P36	MH14	MH15	1	0	1	0.00	1.00	0.00	0.26	6.0	6.57	7.53	2.0	15	87	0.012	0.0008	0.005	4.1	5.0	3.8	0.39	6.95	3.57	3.12	Q ok
P-243	MH-15	MH-244	1	0	1	0.00	1.00	0.00	0.42	6.0	6.95	7.40	**3.12**	15	23	0.012	0.001984	0.0052	4.1	**5.1**	4.3	0.09	7.04	3.02	2.90	Q ok
P-244	MH-244	MH-245	1	0	1	0.00	1.00	0.00	2.08	6.0	7.04	7.40	**15.40**	24	79	0.012	0.003950	0.0089	7.3	**23.1**	7.9	0.17	7.21	2.80	2.10	Q ok
P-245	MH-245	MH-248	1	0	1	0.00	1.00	0.00	5.59	6.0	7.21	7.33	**40.94**	**36**	33	0.012	0.003210	0.0030	5.6	**39.8**	4.6	0.12	7.33	2.00	1.90	Undersizec
P-248	MH-248	MH-252	1	0	1	0.00	1.00	0.00	5.98	6.0	7.33	7.30	**43.60**	**36**	115	0.012	0.003642	0.0033	5.9	**41.5**	4.8	0.40	7.73	1.80	1.42	Undersizec
P-252	MH-252	MH-253	1	0	1	0.00	1.00	0.00	6.30	6.0	7.73	7.16	**45.14**	48	38	0.012	0.000841	0.0032	7.0	**87.4**	6.9	0.09	7.82	1.32	1.20	Q ok
P-253	MH-253	MH-254	1	0	1	0.00	1.00	0.00	6.30	6.0	7.82	7.13	**44.93**	48	102	0.012	0.000834	0.0031	6.9	**87.2**	6.9	0.25	8.07	1.10	0.78	Q ok
P-254	MH-254	OUTFALL	1	0	1	0.00	1.00	0.00	6.30	6.0	8.07	7.03	**44.30**	48	89	0.012	0.000811	0.0030	6.8	**85.7**	6.8	0.22	8.29	0.68	0.41	Q ok
P-240	DI-240	DI-241	4485	497	4982	0.11	1.00	0.11	0.11	6.0	0.00	7.73	**0.88**	15	30	0.012	0.000160	0.0050	4.0	**4.9**	3.0	0.17	6.17	3.72	3.57	Q ok
P-241	DI-241	DI-242	3403	140	3543	0.08	1.00	0.08	0.20	6.0	3.72	7.73	**1.51**	15	20	0.012	0.000467	0.0050	4.0	**4.9**	3.4	0.10	6.10	3.47	3.37	Q ok
P-242	DI-242	MH-244	6783	82	6865	0.16	1.00	0.16	0.35	6.0	3.47	7.73	**2.73**	15	12	0.012	0.001522	0.0050	4.0	**4.9**	4.1	0.05	6.05	3.27	3.21	Q ok
LIMIT FUTURE FLOW FROM A3 TO MACTH 36" PIPE CAPACITY TO MEET CLEARANCE/COVER REQUIREMENTS FOR P-245 & P-248. HOLE 48" OUTFALL																										
ASSUMED FUTURE FLOW ROUTED INTO NEW OUTFALL																										
Existing Offsite Area routed through Ex. 15" TC; Re-Routed to MH-244																										
P-Offsite	Exist Offsite	MH-244	52965	4000	56965	1.31	1.00	1.31	1.31	6.0	0.00	7.73	**10.11**	24	39	0.012	0.001700	0.0051	5.6	**17.6**	5.9	0.11	6.11	3.10	2.90	Q ok
Assumed 1/3 of Future Area 3 Routed to A St Future Trunk Line to P-261																										
P-Future A3	Addl A3	MH-261	**120000**	**0**	**120000**	2.75	1.00	2.75	2.75	6.0	0.00	7.73	**21.29**	30	98	0.012	0.002295	0.0096	8.9	**43.5**	8.8	0.19	6.19	4.20	3.26	Q ok
REMOVED 50,000SF OF A3 FROM ENTERING OUTFALL																										
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																										
P-260	DI-39	MH-261	4465	0	4465	0.10	1.00	0.10	0.10	6.0	0.00	7.73	**0.79**	15	44	0.012	0.000128	0.0032	3.2	**3.9**	2.4	0.30	6.30	3.40	3.26	Q ok
Exist Parcel Flow, Add Future A3 here																										
P-261	MH-261	MH-264	16653	1127	17780	0.41	1.00	0.41	3.27	6.0	6.30	7.63	**24.91**	36	145	0.012	0.001189	0.0030	5.6	**39.8**	6.0	0.40	6.71	3.16	2.72	Q ok
P-264	MH-264	MH-265	0	0	0	0.00	0.00	0.00	3.50	6.0	6.71	7.50	**26.26**	36	61	0.012	0.001321	0.0031	5.7	**40.3**	6.1	0.17	6.87	2.46	2.27	Q ok
P-265	MH-265	MH-245	0	0	0	0.00	0.00	0.00	3.50	6.0	6.87	7.43	**26.03**	36	*46*	0.012	0.001297	0.0037	6.2	**43.9**	6.5	0.12	6.99	2.17	2.00	Q ok
															STUB		22 LF	act length					act.	2.08		
P-262	DI-35&36	MH-264	5579	0	5579	0.13	1.00	0.13	0.13	6.0	0.00	7.73	**0.99**	15	36	0.012	0.000200	0.0031	3.2	**3.9**	2.6	0.23	6.23	3.38	3.27	Q ok
P-263	DI-37&38	MH-264	4770	0	4770	0.11	1.00	0.11	0.11	6.0	0.00	7.73	**0.85**	15	18	0.012	0.000146	0.0056	4.3	**5.2**	3.0	0.10	6.10	2.66	2.56	Q ok
Inlets Constructed in ASI																										
P-246	DI-6	MH-248	9946	0	9946	0.23	1.00	0.23	0.23	6.0	0.00	7.73	**1.76**	15	23	0.012	0.000636	0.0052	4.1	**5.1**	3.7	0.10	6.10	4.72	4.60	Q ok
P-247	DI-7	MH-248	7066	0	7066	0.16	1.00	0.16	0.16	6.0	0.00	7.73	**1.25**	15	26	0.012	0.000321	0.0046	3.9	**4.8**	3.2	0.14	6.14	4.74	4.62	Q ok
P-250	DI-8	MH-251	8718	0	8718	0.20	1.00	0.20	0.20	6.0	0.00	7.73	**1.55**	15	18	0.012	0.000488	0.0050	4.0	**4.9**	3.4	0.09	6.09	6.87	6.78	Q ok
P-251	MH-251	MH-252	0	0	0	0.00	0.00	0.00	0.33	6.0	6.09	7.69	**2.50**	15	54	0.012	0.001278	0.0078	5.0	**6.2**	4.6	0.19	6.29	6.68	6.26	Q ok
P-249	DI-9	MH-248	5442	0	5442	0.12	1.00	0.12	0.12	6.0	0.00	7.73	**0.97**	15	16	0.012	0.000190	0.0044	3.8	**4.6**	2.8	0.09	6.09	7.06	6.99	Q ok
P35	DI10	MH14	4962	681	5643	0.13	1.00	0.13	0.13	6.0	0.00	8.51	1.1	15	18	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.92	3.83	Q ok
P40	DI12	DI11	2375	125	2500	0.06	1.00	0.06	0.06	6.0	0.00	8.51	0.5	15	39	0.012	0.0000	0.005	4.0	4.9	2.4	0.27	6.27	3.67	3.47	Q ok
P37	DI11	MH15	3715	653	4368	0.10	1.00	0.10	0.16	6.0	6.27	8.40	1.3	15	18	0.012	0.0004	0.005	4.0	4.9	3.3	0.09	6.36	3.33	3.24	Q ok
	FUTURE PIPES FOR AREA 3, NOT INCLUDED IN AREA 1 SUBMITTAL																									

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.24	6.24	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.25	8.36	HGL ok
P34	MH13	MH14	1.00	6.22	6.22	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	6.24	8.11	HGL ok
P36	MH14	MH15	1.00	6.14	6.14	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	6.22	7.86	HGL ok
P-243	MH-15	MH-244	1.00	6.08	6.08	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	6.14	7.17	HGL ok
P-244	MH-244	MH-245	1.60	5.63	5.63	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	6.08	7.35	HGL ok
P-245	MH-245	MH-248	2.40	5.35	5.35	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	5.63	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.77	4.77	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	5.35	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.18	4.40	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	4.77	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.81	3.98	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	4.18	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.20**	**3.61**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**3.81**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	6.18	6.18	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.19	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	6.15	6.15	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	6.18	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	6.08	6.08	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	6.15	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	6.08	6.08	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	6.18	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	6.11	6.11	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	6.40	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	6.11	6.11	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.11	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	5.90	5.90	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	6.11	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	5.76	5.76	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	5.90	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	5.63	5.63	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	5.76	6.82	HGL ok
P-262	DI-35&36	MH-264	1.00	5.90	5.90	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.91	7.04	HGL ok
P-263	DI-37&38	MH-264	1.00	5.90	5.90	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.90	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	5.35	5.60	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	5.62	8.38	HGL ok
P-247	DI-7	MH-248	1.00	5.35	5.62	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.63	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.37	7.78	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	6.19	7.26	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	7.37	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.37	7.99	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.00	10.89	HGL ok
P35	DI10	MH14	1.00	6.22	6.22	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.23	8.11	HGL ok
P40	DI12	DI11	1.00	6.15	6.15	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.16	7.19	HGL ok
P37	DI11	MH15	1.00	6.14	6.14	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	6.15	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.24	6.24	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.25	8.36	HGL ok
P34	MH13	MH14	1.00	6.22	6.22	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	6.24	8.11	HGL ok
P36	MH14	MH15	1.00	6.14	6.14	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	6.22	7.86	HGL ok
P-243	MH-15	MH-244	1.00	6.08	6.08	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	6.14	7.17	HGL ok
P-244	MH-244	MH-245	1.60	5.63	5.63	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	6.08	7.35	HGL ok
P-245	MH-245	MH-248	2.40	5.35	5.35	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	5.63	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.77	4.77	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	5.35	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.18	4.40	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	4.77	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.81	3.98	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	4.18	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.40**	**3.61**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**3.81**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	6.18	6.18	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.19	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	6.15	6.15	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	6.18	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	6.08	6.08	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	6.15	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	6.08	6.08	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	6.18	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	6.11	6.11	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	6.40	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	6.11	6.11	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.11	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	5.90	5.90	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	6.11	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	5.76	5.76	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	5.90	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	5.63	5.63	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	5.76	6.82	HGL ok
P-262	DI-35&36	MH-264	1.00	5.90	5.90	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.91	7.04	HGL ok
P-263	DI-37&38	MH-264	1.00	5.90	5.90	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	5.90	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	5.35	5.60	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	5.62	8.38	HGL ok
P-247	DI-7	MH-248	1.00	5.35	5.62	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.63	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.37	7.78	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	7.79	10.19	HGL ok
P-251	MH-251	MH-252	1.00	6.19	7.26	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	7.37	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.37	7.99	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.00	10.89	HGL ok
P35	DI10	MH14	1.00	6.22	6.22	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.23	8.11	HGL ok
P40	DI12	DI11	1.00	6.15	6.15	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.16	7.19	HGL ok
P37	DI11	MH15	1.00	6.14	6.14	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	6.15	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ftnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.14	9.14	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.15	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.12	9.12	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	9.14	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.04	9.04	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	9.12	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.98	8.98	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	9.04	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.54	8.54	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	8.98	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.25	8.25	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	8.54	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.67	7.67	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	8.25	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.30	7.30	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	7.67	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.10	7.10	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	7.30	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**7.10**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	9.08	9.08	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.09	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.05	9.05	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	9.08	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.98	8.98	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	9.05	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.98	8.98	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	9.08	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.01	9.01	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	9.31	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.01	9.01	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.01	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.80	8.80	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	9.01	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.66	8.66	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	8.80	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.54	8.54	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	8.66	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.80	8.80	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.81	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.80	8.80	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.80	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.25	8.25	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.28	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.25	8.25	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.27	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.20	9.20	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	9.21	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.09	9.09	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	9.20	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.20	9.20	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.20	10.89	HGL ok
P35	DI10	MH14	1.00	9.12	9.12	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.13	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.06	9.06	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.06	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.04	9.04	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	9.06	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.64	9.64	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.65	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.62	9.62	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	9.64	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.54	9.54	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	9.62	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.48	9.48	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	9.54	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.04	9.04	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	9.48	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.75	8.75	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	9.04	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.17	8.17	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	8.75	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.80	7.80	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	8.17	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.60	7.60	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	7.80	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**7.60**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	9.58	9.58	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.59	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.55	9.55	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	9.58	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.48	9.48	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	9.55	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.48	9.48	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	9.58	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.51	9.51	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	9.81	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.51	9.51	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.51	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.30	9.30	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	9.51	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.16	9.16	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	9.30	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.04	9.04	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	9.16	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.30	9.30	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.31	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.30	9.30	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.30	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.75	8.75	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.78	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.75	8.75	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.77	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.70	9.70	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	9.71	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.59	9.59	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	9.70	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.70	9.70	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.70	10.89	HGL ok
P35	DI10	MH14	1.00	9.62	9.62	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.63	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.56	9.56	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.56	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.54	9.54	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	9.56	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.04	10.04	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.05	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.02	10.02	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	10.04	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.94	9.94	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	10.02	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.88	9.88	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	9.94	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.44	9.44	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	9.88	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.15	9.15	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	9.44	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.57	8.57	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	9.15	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.20	8.20	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	8.57	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	8.00	8.00	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	8.20	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**8.00**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	9.98	9.98	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.99	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.95	9.95	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	9.98	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.88	9.88	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	9.95	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.88	9.88	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	9.98	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.91	9.91	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	10.21	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.91	9.91	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.91	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.70	9.70	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	9.91	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.56	9.56	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	9.70	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.44	9.44	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	9.56	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.70	9.70	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.71	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.70	9.70	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.70	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.15	9.15	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.18	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.15	9.15	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.17	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.10	10.10	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	10.11	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.99	9.99	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	10.10	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.10	10.10	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.10	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.02	10.02	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.03	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.96	9.96	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.96	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.94	9.94	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	9.96	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.54	10.54	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.55	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.52	10.52	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	10.54	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.44	10.44	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	10.52	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.38	10.38	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	10.44	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.94	9.94	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	10.38	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.65	9.65	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	9.94	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.07	9.07	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	9.65	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.70	8.70	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	9.07	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	8.50	8.50	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	8.70	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**8.50**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.48	10.48	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.49	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.45	10.45	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	10.48	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.38	10.38	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	10.45	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.38	10.38	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	10.48	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.41	10.41	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	10.71	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.41	10.41	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.41	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.20	10.20	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	10.41	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.06	10.06	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	10.20	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.94	9.94	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	10.06	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.20	10.20	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.21	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.20	10.20	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.20	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.65	9.65	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.68	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.65	9.65	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.67	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.60	10.60	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	10.61	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.49	10.49	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	10.60	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.60	10.60	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.60	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.52	10.52	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.53	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.46	10.46	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.46	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.44	10.44	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	10.46	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5	
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077	
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)				

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.24	11.24	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.25	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.22	11.22	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	11.24	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.14	11.14	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	11.22	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.08	11.08	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	11.14	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.64	10.64	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	11.08	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.35	10.35	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	10.64	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.77	9.77	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	10.35	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.40	9.40	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	9.77	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.20	9.20	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	9.40	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**9.20**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.18	11.18	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.19	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.15	11.15	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	11.18	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.08	11.08	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	11.15	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.08	11.08	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	11.18	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.11	11.11	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	11.41	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.11	11.11	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.11	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.90	10.90	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	11.11	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.76	10.76	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	10.90	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.64	10.64	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	10.76	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.90	10.90	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.91	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.90	10.90	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.90	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.35	10.35	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.38	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.35	10.35	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.37	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.30	11.30	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	11.31	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.19	11.19	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	11.30	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.30	11.30	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.30	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.22	11.22	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.23	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.16	11.16	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.16	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.14	11.14	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	11.16	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.74	11.74	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.75	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.72	11.72	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	11.74	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.64	11.64	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	11.72	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.58	11.58	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	11.64	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.14	11.14	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	11.58	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.85	10.85	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	11.14	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.27	10.27	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	10.85	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.90	9.90	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	10.27	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.70	9.70	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	9.90	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**9.70**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.68	11.68	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.69	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.65	11.65	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	11.68	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.58	11.58	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	11.65	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.58	11.58	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	11.68	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.61	11.61	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	11.91	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.61	11.61	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.61	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.40	11.40	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	11.61	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.26	11.26	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	11.40	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.14	11.14	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	11.26	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.40	11.40	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.41	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.40	11.40	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.40	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.85	10.85	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.88	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.85	10.85	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.87	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.80	11.80	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	11.81	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.69	11.69	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	11.80	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.80	11.80	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.80	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.72	11.72	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.73	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.66	11.66	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.66	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.64	11.64	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	11.66	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.04	13.04	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.05	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.02	13.02	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	13.04	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.94	12.94	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	13.02	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.88	12.88	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	12.94	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.44	12.44	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	12.88	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.15	12.15	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	12.44	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.57	11.57	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	12.15	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.20	11.20	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	11.57	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.00	11.00	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	11.20	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**11.00**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.98	12.98	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.99	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.95	12.95	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	12.98	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.88	12.88	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	12.95	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.88	12.88	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	12.98	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.91	12.91	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	13.21	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.91	12.91	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.91	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.70	12.70	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	12.91	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.56	12.56	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	12.70	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.44	12.44	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	12.56	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.70	12.70	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.71	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.70	12.70	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.70	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.15	12.15	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.18	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.15	12.15	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.17	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.10	13.10	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	13.11	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.99	12.99	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	13.10	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.10	13.10	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.10	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.02	13.02	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.03	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.96	12.96	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.96	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.94	12.94	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	12.96	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	7.98	7.98	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.99	8.36	HGL Too High!
P34	MH13	MH14	1.00	7.96	7.96	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	7.98	8.11	HGL Too High!
P36	MH14	MH15	1.00	7.88	7.88	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	7.96	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	7.82	7.82	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	7.88	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.38	7.38	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	7.82	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.09	7.09	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	7.38	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	6.51	6.51	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	7.09	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.14	6.14	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	6.51	9.40	HGL ok
P-253	MH-253	MH-254	3.20	5.94	5.94	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	6.14	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**5.94**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	7.92	7.92	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.93	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	7.89	7.89	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	7.92	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	7.82	7.82	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	7.89	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	7.82	7.82	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	7.92	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	7.85	7.85	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	8.15	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	7.85	7.85	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.85	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	7.64	7.64	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	7.85	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.50	7.50	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	7.64	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.38	7.38	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	7.50	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	7.64	7.64	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.65	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	7.64	7.64	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.64	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.09	7.09	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.12	8.38	HGL ok
P-247	DI-7	MH-248	1.00	7.09	7.09	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.11	8.39	HGL ok
P-250	DI-8	MH-251	1.00	8.04	8.04	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	8.05	10.19	HGL ok
P-251	MH-251	MH-252	1.00	7.93	7.93	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	8.04	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.04	8.04	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.04	10.89	HGL ok
P35	DI10	MH14	1.00	7.96	7.96	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.97	8.11	HGL Too High!
P40	DI12	DI11	1.00	7.90	7.90	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.90	7.19	HGL Too High!
P37	DI11	MH15	1.00	7.88	7.88	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	7.90	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.18	8.18	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.19	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.16	8.16	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	8.18	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.08	8.08	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	8.16	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.02	8.02	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	8.08	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.58	7.58	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	8.02	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.29	7.29	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	7.58	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	6.71	6.71	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	7.29	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.34	6.34	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	6.71	9.40	HGL ok
P-253	MH-253	MH-254	3.20	6.14	6.14	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	6.34	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**6.14**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	8.12	8.12	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.13	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.09	8.09	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	8.12	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.02	8.02	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	8.09	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.02	8.02	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	8.12	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.05	8.05	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	8.35	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.05	8.05	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.05	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	7.84	7.84	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	8.05	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.70	7.70	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	7.84	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.58	7.58	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	7.70	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	7.84	7.84	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.85	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	7.84	7.84	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.84	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.29	7.29	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.32	8.38	HGL ok
P-247	DI-7	MH-248	1.00	7.29	7.29	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.31	8.39	HGL ok
P-250	DI-8	MH-251	1.00	8.24	8.24	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	8.25	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.13	8.13	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	8.24	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.24	8.24	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.24	10.89	HGL ok
P35	DI10	MH14	1.00	8.16	8.16	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.17	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.10	8.10	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.10	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.08	8.08	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	8.10	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.68	11.68	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.69	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.66	11.66	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	11.68	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.58	11.58	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	11.66	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.52	11.52	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	11.58	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.08	11.08	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	11.52	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.79	10.79	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	11.08	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.21	10.21	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	10.79	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.84	9.84	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	10.21	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.64	9.64	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	9.84	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**9.64**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.62	11.62	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.63	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.59	11.59	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	11.62	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.52	11.52	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	11.59	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.52	11.52	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	11.62	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.55	11.55	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	11.85	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.55	11.55	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.55	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.34	11.34	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	11.55	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.20	11.20	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	11.34	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.08	11.08	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	11.20	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.34	11.34	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.35	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.34	11.34	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.34	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.79	10.79	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.82	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.79	10.79	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.81	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.74	11.74	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	11.75	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.63	11.63	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	11.74	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.74	11.74	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.74	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.66	11.66	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.67	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.60	11.60	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.60	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.58	11.58	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	11.60	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.18	12.18	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.19	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.16	12.16	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	12.18	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.08	12.08	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	12.16	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.02	12.02	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	12.08	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.58	11.58	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	12.02	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.29	11.29	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	11.58	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.71	10.71	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	11.29	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.34	10.34	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	10.71	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.14	10.14	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	10.34	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**10.14**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.12	12.12	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.13	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.09	12.09	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	12.12	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.02	12.02	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	12.09	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.02	12.02	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	12.12	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.05	12.05	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	12.35	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.05	12.05	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.05	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.84	11.84	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	12.05	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.70	11.70	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	11.84	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.58	11.58	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	11.70	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.84	11.84	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.85	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.84	11.84	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.84	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.29	11.29	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.32	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.29	11.29	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.31	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.24	12.24	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.25	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.13	12.13	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	12.24	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.24	12.24	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.24	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.16	12.16	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.17	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.10	12.10	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.10	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.08	12.08	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	12.10	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.58	12.58	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.59	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.56	12.56	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	12.58	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.48	12.48	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	12.56	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.42	12.42	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	12.48	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.98	11.98	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	12.42	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.69	11.69	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	11.98	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.11	11.11	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	11.69	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.74	10.74	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	11.11	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.54	10.54	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	10.74	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**10.54**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.52	12.52	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.53	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.49	12.49	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	12.52	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.42	12.42	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	12.49	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.42	12.42	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	12.52	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.45	12.45	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	12.75	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.45	12.45	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.45	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.24	12.24	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	12.45	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.10	12.10	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	12.24	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.98	11.98	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	12.10	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.24	12.24	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.25	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.24	12.24	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.24	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.69	11.69	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.72	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.69	11.69	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.71	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.64	12.64	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.65	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.53	12.53	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	12.64	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.64	12.64	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.64	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.56	12.56	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.57	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.50	12.50	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.50	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.48	12.48	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	12.50	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.08	13.08	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.09	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.06	13.06	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	13.08	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.98	12.98	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	13.06	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.92	12.92	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	12.98	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.48	12.48	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	12.92	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.19	12.19	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	12.48	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.61	11.61	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	12.19	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.24	11.24	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	11.61	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.04	11.04	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	11.24	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**11.04**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.02	13.02	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.03	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.99	12.99	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	13.02	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.92	12.92	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	12.99	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.92	12.92	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	13.02	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.95	12.95	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	13.25	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.95	12.95	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.95	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.74	12.74	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	12.95	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.60	12.60	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	12.74	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.48	12.48	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	12.60	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.74	12.74	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.75	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.74	12.74	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.74	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.19	12.19	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.22	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.19	12.19	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.21	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.14	13.14	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	13.15	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.03	13.03	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	13.14	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.14	13.14	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.14	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.06	13.06	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.07	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.00	13.00	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.00	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.98	12.98	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	13.00	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.78	13.78	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.79	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.76	13.76	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	13.78	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.68	13.68	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	13.76	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.62	13.62	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	13.68	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	13.18	13.18	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	13.62	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.89	12.89	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	13.18	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.31	12.31	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	12.89	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.94	11.94	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	12.31	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.74	11.74	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	11.94	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**11.74**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.72	13.72	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.73	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.69	13.69	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	13.72	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.62	13.62	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	13.69	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.62	13.62	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	13.72	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.65	13.65	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	13.95	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.65	13.65	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.65	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.44	13.44	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	13.65	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	13.30	13.30	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	13.44	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	13.18	13.18	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	13.30	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.44	13.44	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.45	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.44	13.44	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.44	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.89	12.89	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.92	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.89	12.89	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.91	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.84	13.84	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	13.85	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.73	13.73	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	13.84	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.84	13.84	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.84	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.76	13.76	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.77	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.70	13.70	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.70	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.68	13.68	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	13.70	7.09	HGL Too High!

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Hydraulic Grade Line Computations

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	14.28	14.28	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.29	8.36	HGL Too High!
P34	MH13	MH14	1.00	14.26	14.26	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	14.28	8.11	HGL Too High!
P36	MH14	MH15	1.00	14.18	14.18	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	14.26	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	14.12	14.12	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	14.18	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	13.68	13.68	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	14.12	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	13.39	13.39	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	13.68	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.81	12.81	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	13.39	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	12.44	12.44	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	12.81	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	12.24	12.24	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	12.44	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**12.24**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	14.22	14.22	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.23	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	14.19	14.19	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	14.22	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	14.12	14.12	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	14.19	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	14.12	14.12	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	14.22	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	14.15	14.15	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	14.45	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	14.15	14.15	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.15	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.94	13.94	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	14.15	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	13.80	13.80	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	13.94	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	13.68	13.68	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	13.80	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.94	13.94	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.95	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.94	13.94	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.94	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	13.39	13.39	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.42	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	13.39	13.39	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.41	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	14.34	14.34	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	14.35	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	14.23	14.23	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	14.34	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	14.34	14.34	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.34	10.89	HGL Too High!
P35	DI10	MH14	1.00	14.26	14.26	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.27	8.11	HGL Too High!
P40	DI12	DI11	1.00	14.20	14.20	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.20	7.19	HGL Too High!
P37	DI11	MH15	1.00	14.18	14.18	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	14.20	7.09	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	15.58	15.58	15	1.0	0.8	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.59	8.36	HGL Too High!
P34	MH13	MH14	1.00	15.56	15.56	15	1.0	0.8	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.8	0.0	90	0.01	0.01	1.0	0.5	0.01	0.02	15.58	8.11	HGL Too High!
P36	MH14	MH15	1.00	15.48	15.48	15	2.0	1.6	0	87.2	0.0008	0.07	0	0.00	0.01	0.9	0.0	0.0	0.8	0.0	0	0.00	0.01	1.3	0.5	0.01	0.08	15.56	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	15.42	15.42	15	3.1	2.5	12.7	23	0.0020	0.05	0	0.00	0.03	3.2	1.4	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	15.48	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	14.98	14.98	24	15.4	4.9	45	79	0.0039	0.31	0	0.00	0.09	7.9	6.1	32.5	3.2	0.1	90	0.11	0.26	1.0	0.5	0.13	0.44	15.42	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	14.69	14.69	36	40.9	5.8	0	33	0.0032	0.11	1	0.00	0.13	75.5	95.8	0.0	3.7	0.1	90	0.15	0.35	1.0	0.5	0.18	0.28	14.98	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	14.11	14.11	36	43.6	6.2	90	115	0.0036	0.42	2	0.00	0.15	237.1	2.5	1.3	5.8	0.2	0	0.00	0.33	1.0	0.5	0.17	0.58	14.69	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	13.74	13.74	48	45.1	3.6	90	38	0.0008	0.03	0	0.00	0.05	269.0	5.1	0.0	6.2	0.2	90	0.41	0.67	1.0	0.5	0.34	0.37	14.11	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	13.54	13.54	48	44.9	3.6	16.6	102	0.0008	0.09	0	0.00	0.05	237.1	0.0	0.0	5.8	0.2	0	0.00	0.23	1.0	0.5	0.12	0.20	13.74	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**44.3**	**3.5**	**0**	**89**	**0.0008**	**0.07**	**0**	**0.00**	**0.05**	**162.1**	**0.0**	**0.0**	**3.6**	**0.1**	**90**	**0.14**	**0.26**	**1.0**	**0.5**	**0.13**	**0.20**	**13.54**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	15.52	15.52	15	0.9	0.7	90	30	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.53	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	15.49	15.49	15	1.5	1.2	90	20	0.0005	0.01	0	0.00	0.01	0.6	0.0	0.0	0.7	0.0	90	0.01	0.01	1.3	1.0	0.02	0.03	15.52	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	15.42	15.42	15	2.7	2.2	90	12	0.0015	0.02	0	0.00	0.02	1.9	0.0	0.0	1.2	0.0	90	0.02	0.04	1.3	1.0	0.06	0.08	15.49	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	15.42	15.42	24	10.1	3.2	90	39	0.0017	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.11	15.52	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	15.45	15.45	30	21.3	4.3	90	98	0.0023	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.30	15.75	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	15.45	15.45	15	0.8	0.6	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.45	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	15.24	15.24	36	24.9	3.5	0	145	0.0012	0.17	0	0.00	0.05	0.5	0.0	0.0	0.6	0.0	90	0.00	0.06	1.3	0.5	0.04	0.21	15.45	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	15.10	15.10	36	26.3	3.7	0	61	0.0013	0.08	0	0.00	0.05	87.8	0.8	0.6	3.5	0.1	0	0.00	0.12	1.0	0.5	0.06	0.14	15.24	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	14.98	14.98	36	26.0	3.7	90	46	0.0013	0.06	0	0.00	0.05	97.5	0.0	0.0	3.7	0.1	0	0.00	0.13	1.0	0.5	0.06	0.12	15.10	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	15.24	15.24	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.25	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	15.24	15.24	15	0.8	0.7	90	18	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.24	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	14.69	14.69	15	1.8	1.4	90	23	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	14.72	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	14.69	14.69	15	1.3	1.0	90	26	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.71	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	15.64	15.64	15	1.5	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	15.65	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	15.53	15.53	15	2.5	2.0	91.5	54	0.0013	0.07	0	0.00	0.02	1.9	0.8	0.0	1.3	0.0	85.5	0.02	0.04	1.0	1.0	0.04	0.11	15.64	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	15.64	15.64	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.64	10.89	HGL Too High!
P35	DI10	MH14	1.00	15.56	15.56	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.57	8.11	HGL Too High!
P40	DI12	DI11	1.00	15.50	15.50	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.50	7.19	HGL Too High!
P37	DI11	MH15	1.00	15.48	15.48	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	15.50	7.09	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 5 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: Market Street Outfall (North) | Storm Frequency: 200 -year (50-year for sumps)
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Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P33	DI24	MH13	4615	1621	6236	0.14	0.94	0.13	0.13	6.0	6.17	8.02	1.1	15	30	0.012	0.0002	0.005	4.1	5.1	3.1	0.16	6.33	4.17	4.01	Q ok
P34	MH13	MH14	1	0	1	0.00	1.00	0.00	0.13	6.0	6.33	7.99	1.1	15	44	0.012	0.0002	0.005	4.1	5.0	3.1	0.24	6.57	3.91	3.68	Q ok
P36	MH14	MH15	1	0	1	0.00	1.00	0.00	0.26	6.0	6.57	7.88	2.1	15	87	0.012	0.0009	0.005	4.1	5.0	3.8	0.39	6.95	3.57	3.12	Q ok
P-243	MH-15	MH-244	1	0	1	0.00	1.00	0.00	0.42	6.0	6.95	7.74	**3.26**	15	23	0.012	0.002172	0.0052	4.1	**5.1**	4.4	0.09	7.04	3.02	2.90	Q ok
P-244	MH-244	MH-245	1	0	1	0.00	1.00	0.00	2.08	6.0	7.04	7.74	**16.12**	24	79	0.012	0.004326	0.0089	7.3	**23.1**	8.0	0.16	7.20	2.80	2.10	Q ok
P-245	MH-245	MH-248	1	0	1	0.00	1.00	0.00	5.59	6.0	7.20	7.67	**42.84**	**36**	33	0.012	0.003515	0.0030	5.6	**39.8**	4.6	0.12	7.32	2.00	1.90	Undersizec
P-248	MH-248	MH-252	1	0	1	0.00	1.00	0.00	5.98	6.0	7.32	7.64	**45.63**	**36**	115	0.012	0.003988	0.0033	5.9	**41.5**	4.8	0.40	7.72	1.80	1.42	Undersizec
P-252	MH-252	MH-253	1	0	1	0.00	1.00	0.00	6.30	6.0	7.72	7.50	**47.23**	48	38	0.012	0.000921	0.0032	7.0	**87.4**	7.1	0.09	7.81	1.32	1.20	Q ok
P-253	MH-253	MH-254	1	0	1	0.00	1.00	0.00	6.30	6.0	7.81	7.46	**47.01**	48	102	0.012	0.000913	0.0031	6.9	**87.2**	7.1	0.24	8.05	1.10	0.78	Q ok
P-254	MH-254	OUTFALL	1	0	1	0.00	1.00	0.00	6.30	6.0	8.05	7.36	**46.35**	48	89	0.012	0.000887	0.0030	6.8	**85.7**	7.0	0.21	8.26	0.68	0.41	Q ok
P-240	DI-240	DI-241	4485	497	4982	0.11	1.00	0.11	0.11	6.0	0.00	8.09	**0.93**	15	30	0.012	0.000175	0.0050	4.0	**4.9**	3.0	0.17	6.17	3.72	3.57	Q ok
P-241	DI-241	DI-242	3403	140	3543	0.08	1.00	0.08	0.20	6.0	3.72	8.09	**1.58**	15	20	0.012	0.000512	0.0050	4.0	**4.9**	3.4	0.10	6.10	3.47	3.37	Q ok
P-242	DI-242	MH-244	6783	82	6865	0.16	1.00	0.16	0.35	6.0	3.47	8.09	**2.86**	15	12	0.012	0.001668	0.0050	4.0	**4.9**	4.2	0.05	6.05	3.27	3.21	Q ok
LIMIT FUTURE FLOW FROM A3 TO MACTH 36" PIPE CAPACITY TO MEET CLEARANCE/COVER REQUIREMENTS FOR P-245 & P-248. HOLE 48" OUTFALL																										
ASSUMED FUTURE FLOW ROUTED INTO NEW OUTFALL																										
Existing Offsite Area routed through Ex. 15" TC; Re-Routed to MH-244																										
P-Offsite	Exist Offsite	MH-244	52965	4000	56965	1.31	1.00	1.31	1.31	6.0	0.00	8.09	**10.58**	24	39	0.012	0.001864	0.0051	5.6	**17.6**	5.9	0.11	6.11	3.10	2.90	Q ok
Assumed 1/3 of Future Area 3 Routed to A St Future Trunk Line to P-261																										
P-Future A3	Addl A3	MH-261	**120000**	**0**	**120000**	2.75	1.00	2.75	2.75	6.0	0.00	8.09	**22.29**	30	98	0.012	0.002516	0.0096	8.9	**43.5**	8.8	0.19	6.19	4.20	3.26	Q ok
REMOVED 50,000SF OF A3 FROM ENTERING OUTFALL																										
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																										
P-260	DI-39	MH-261	4465	0	4465	0.10	1.00	0.10	0.10	6.0	0.00	8.09	**0.83**	15	44	0.012	0.000140	0.0032	3.2	**3.9**	2.4	0.30	6.30	3.40	3.26	Q ok
Exist Parcel Flow, Add Future A3 here																										
P-261	MH-261	MH-264	16653	1127	17780	0.41	1.00	0.41	3.27	6.0	6.30	7.99	**26.08**	36	145	0.012	0.001302	0.0030	5.6	**39.8**	6.0	0.40	6.71	3.16	2.72	Q ok
P-264	MH-264	MH-265	0	0	0	0.00	0.00	0.00	3.50	6.0	6.71	7.85	**27.48**	36	61	0.012	0.001447	0.0031	5.7	**40.3**	6.2	0.16	6.87	2.46	2.27	Q ok
P-265	MH-265	MH-245	0	0	0	0.00	0.00	0.00	3.50	6.0	6.87	7.78	**27.24**	36	*46*	0.012	0.001421	0.0037	6.2	**43.9**	6.5	0.12	6.99	2.17	2.00	Q ok
															STUB		22 LF	act length					act.	2.08		
P-262	DI-35&36	MH-264	5579	0	5579	0.13	1.00	0.13	0.13	6.0	0.00	8.09	**1.04**	15	36	0.012	0.000219	0.0031	3.2	**3.9**	2.6	0.23	6.23	3.38	3.27	Q ok
P-263	DI-37&38	MH-264	4770	0	4770	0.11	1.00	0.11	0.11	6.0	0.00	8.09	**0.89**	15	18	0.012	0.000160	0.0056	4.3	**5.2**	3.0	0.10	6.10	2.66	2.56	Q ok
Inlets Constructed in ASI																										
P-246	DI-6	MH-248	9946	0	9946	0.23	1.00	0.23	0.23	6.0	0.00	8.09	**1.85**	15	23	0.012	0.000697	0.0052	4.1	**5.1**	3.7	0.10	6.10	4.72	4.60	Q ok
P-247	DI-7	MH-248	7066	0	7066	0.16	1.00	0.16	0.16	6.0	0.00	8.09	**1.31**	15	26	0.012	0.000352	0.0046	3.9	**4.8**	3.3	0.13	6.13	4.74	4.62	Q ok
P-250	DI-8	MH-251	8718	0	8718	0.20	1.00	0.20	0.20	6.0	0.00	8.09	**1.62**	15	18	0.012	0.000535	0.0050	4.0	**4.9**	3.6	0.08	6.08	6.87	6.78	Q ok
P-251	MH-251	MH-252	0	0	0	0.00	0.00	0.00	0.33	6.0	6.09	8.06	**2.62**	15	54	0.012	0.001400	0.0078	5.0	**6.2**	4.6	0.19	6.29	6.68	6.26	Q ok
P-249	DI-9	MH-248	5442	0	5442	0.12	1.00	0.12	0.12	6.0	0.00	8.09	**1.01**	15	16	0.012	0.000209	0.0044	3.8	**4.6**	2.8	0.09	6.09	7.06	6.99	Q ok
P35	DI10	MH14	4962	681	5643	0.13	1.00	0.13	0.13	6.0	0.00	8.51	1.1	15	18	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.92	3.83	Q ok
P40	DI12	DI11	2375	125	2500	0.06	1.00	0.06	0.06	6.0	0.00	8.51	0.5	15	39	0.012	0.0000	0.005	4.0	4.9	2.4	0.27	6.27	3.67	3.47	Q ok
P37	DI11	MH15	3715	653	4368	0.10	1.00	0.10	0.16	6.0	6.27	8.40	1.3	15	18	0.012	0.0004	0.005	4.0	4.9	3.3	0.09	6.36	3.33	3.24	Q ok
	FUTURE PIPES FOR AREA 3, NOT INCLUDED IN AREA 1 SUBMITTAL																									

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.41	6.41	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.42	8.36	HGL ok
P34	MH13	MH14	1.00	6.39	6.39	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	6.41	8.11	HGL ok
P36	MH14	MH15	1.00	6.31	6.31	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	6.39	7.86	HGL ok
P-243	MH-15	MH-244	1.00	6.23	6.23	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	6.31	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	5.75	5.75	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	6.23	7.35	HGL ok
P-245	MH-245	MH-248	2.40	5.44	5.44	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	5.75	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.80	4.80	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	5.44	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.20	4.40	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	4.80	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.83	3.98	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	4.20	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.20**	**3.61**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**3.83**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	6.35	6.35	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.36	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	6.32	6.32	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	6.35	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	6.23	6.23	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	6.32	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	6.23	6.23	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	6.35	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	6.27	6.27	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	6.59	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	6.27	6.27	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.28	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	6.04	6.04	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	6.27	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	5.88	5.88	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	6.04	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	5.75	5.75	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	5.88	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	6.04	6.04	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.05	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	6.04	6.04	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.04	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	5.44	5.60	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	5.62	8.38	HGL ok
P-247	DI-7	MH-248	1.00	5.44	5.62	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.63	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.38	7.78	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.80	10.19	HGL ok
P-251	MH-251	MH-252	1.00	6.36	7.26	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	7.38	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.38	7.99	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.00	10.89	HGL ok
P35	DI10	MH14	1.00	6.39	6.39	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.40	8.11	HGL ok
P40	DI12	DI11	1.00	6.32	6.32	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.32	7.19	HGL Too High!
P37	DI11	MH15	1.00	6.31	6.31	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	6.32	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.41	6.41	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.42	8.36	HGL ok
P34	MH13	MH14	1.00	6.39	6.39	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	6.41	8.11	HGL ok
P36	MH14	MH15	1.00	6.31	6.31	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	6.39	7.86	HGL ok
P-243	MH-15	MH-244	1.00	6.23	6.23	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	6.31	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	5.75	5.75	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	6.23	7.35	HGL ok
P-245	MH-245	MH-248	2.40	5.44	5.44	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	5.75	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.80	4.80	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	5.44	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.20	4.40	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	4.80	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.83	3.98	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	4.20	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.40**	**3.61**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**3.83**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	6.35	6.35	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.36	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	6.32	6.32	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	6.35	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	6.23	6.23	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	6.32	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	6.23	6.23	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	6.35	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	6.27	6.27	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	6.59	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	6.27	6.27	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.28	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	6.04	6.04	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	6.27	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	5.88	5.88	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	6.04	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	5.75	5.75	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	5.88	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	6.04	6.04	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.05	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	6.04	6.04	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.04	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	5.44	5.60	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	5.62	8.38	HGL ok
P-247	DI-7	MH-248	1.00	5.44	5.62	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	5.63	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.38	7.78	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.80	10.19	HGL ok
P-251	MH-251	MH-252	1.00	6.36	7.26	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	7.38	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.38	7.99	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.00	10.89	HGL ok
P35	DI10	MH14	1.00	6.39	6.39	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.40	8.11	HGL ok
P40	DI12	DI11	1.00	6.32	6.32	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.32	7.19	HGL Too High!
P37	DI11	MH15	1.00	6.31	6.31	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	6.32	7.09	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*Q*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.35	9.35	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.36	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.33	9.33	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	9.35	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.25	9.25	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	9.33	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.18	9.18	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	9.25	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.69	8.69	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	9.18	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.38	8.38	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	8.69	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.74	7.74	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	8.38	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.34	7.34	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	7.74	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.12	7.12	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	7.34	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**7.12**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	9.29	9.29	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.30	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.26	9.26	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	9.29	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.18	9.18	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	9.26	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.18	9.18	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	9.29	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.21	9.21	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	9.53	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.21	9.21	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.22	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.98	8.98	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	9.21	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.83	8.83	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	8.98	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.69	8.69	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	8.83	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.98	8.98	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.99	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.98	8.98	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.98	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.38	8.38	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.41	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.38	8.38	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.40	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.42	9.42	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.43	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.30	9.30	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	9.42	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.42	9.42	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.42	10.89	HGL ok
P35	DI10	MH14	1.00	9.33	9.33	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.34	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.26	9.26	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.26	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.25	9.25	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	9.26	7.09	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.85	9.85	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.86	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.83	9.83	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	9.85	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.75	9.75	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	9.83	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.68	9.68	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	9.75	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.19	9.19	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	9.68	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.88	8.88	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	9.19	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.24	8.24	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	8.88	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.84	7.84	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	8.24	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.62	7.62	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	7.84	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**7.62**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	9.79	9.79	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.80	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.76	9.76	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	9.79	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.68	9.68	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	9.76	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.68	9.68	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	9.79	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.71	9.71	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	10.03	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.71	9.71	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.72	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.48	9.48	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	9.71	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.33	9.33	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	9.48	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.19	9.19	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	9.33	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.48	9.48	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.49	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.48	9.48	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.48	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.88	8.88	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.91	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.88	8.88	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.90	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.92	9.92	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.93	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.80	9.80	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	9.92	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.92	9.92	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.92	10.89	HGL Too High!
P35	DI10	MH14	1.00	9.83	9.83	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.84	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.76	9.76	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.76	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.75	9.75	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	9.76	7.09	HGL Too High!

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RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.25	10.25	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.26	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.23	10.23	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	10.25	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.15	10.15	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	10.23	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.08	10.08	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	10.15	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.59	9.59	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	10.08	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.28	9.28	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	9.59	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.64	8.64	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	9.28	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.24	8.24	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	8.64	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	8.02	8.02	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	8.24	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**8.02**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.19	10.19	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.20	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.16	10.16	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	10.19	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.08	10.08	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	10.16	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.08	10.08	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	10.19	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.11	10.11	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	10.43	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.11	10.11	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.12	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.88	9.88	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	10.11	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.73	9.73	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	9.88	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.59	9.59	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	9.73	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.88	9.88	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.89	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.88	9.88	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.88	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.28	9.28	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.31	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.28	9.28	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.30	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.32	10.32	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.33	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.20	10.20	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	10.32	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.32	10.32	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.32	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.23	10.23	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.24	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.16	10.16	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.16	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.15	10.15	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	10.16	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ftnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.75	10.75	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.76	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.73	10.73	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	10.75	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.65	10.65	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	10.73	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.58	10.58	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	10.65	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.09	10.09	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	10.58	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.78	9.78	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	10.09	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.14	9.14	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	9.78	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.74	8.74	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	9.14	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	8.52	8.52	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	8.74	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**8.52**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.69	10.69	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.70	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.66	10.66	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	10.69	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.58	10.58	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	10.66	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.58	10.58	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	10.69	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.61	10.61	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	10.93	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.61	10.61	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.62	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.38	10.38	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	10.61	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.23	10.23	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	10.38	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.09	10.09	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	10.23	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.38	10.38	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.39	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.38	10.38	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.38	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.78	9.78	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.81	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.78	9.78	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.80	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.82	10.82	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.83	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.70	10.70	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	10.82	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.82	10.82	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.82	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.73	10.73	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.74	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.66	10.66	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.66	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.65	10.65	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	10.66	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ftnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.45	11.45	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.46	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.43	11.43	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	11.45	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.35	11.35	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	11.43	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.28	11.28	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	11.35	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.79	10.79	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	11.28	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.48	10.48	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	10.79	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.84	9.84	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	10.48	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.44	9.44	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	9.84	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.22	9.22	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	9.44	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**9.22**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.39	11.39	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.40	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.36	11.36	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	11.39	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.28	11.28	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	11.36	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.28	11.28	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	11.39	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.31	11.31	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	11.63	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.31	11.31	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.32	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.08	11.08	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	11.31	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.93	10.93	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	11.08	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.79	10.79	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	10.93	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.08	11.08	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.09	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.08	11.08	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.08	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.48	10.48	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.51	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.48	10.48	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.50	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.52	11.52	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.53	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.40	11.40	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	11.52	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.52	11.52	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.52	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.43	11.43	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.44	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.36	11.36	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.36	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.35	11.35	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	11.36	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.95	11.95	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.96	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.93	11.93	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	11.95	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.85	11.85	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	11.93	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.78	11.78	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	11.85	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.29	11.29	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	11.78	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.98	10.98	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	11.29	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.34	10.34	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	10.98	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.94	9.94	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	10.34	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.72	9.72	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	9.94	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**9.72**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.89	11.89	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.90	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.86	11.86	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	11.89	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.78	11.78	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	11.86	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.78	11.78	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	11.89	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.81	11.81	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	12.13	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.81	11.81	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.82	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.58	11.58	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	11.81	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.43	11.43	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	11.58	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.29	11.29	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	11.43	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.58	11.58	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.59	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.58	11.58	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.58	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.98	10.98	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.01	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.98	10.98	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.00	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.02	12.02	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.03	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.90	11.90	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	12.02	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.02	12.02	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.02	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.93	11.93	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.94	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.86	11.86	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.86	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.85	11.85	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	11.86	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ftnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.25	13.25	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.26	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.23	13.23	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	13.25	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.15	13.15	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	13.23	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.08	13.08	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	13.15	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.59	12.59	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	13.08	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.28	12.28	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	12.59	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.64	11.64	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	12.28	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.24	11.24	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	11.64	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.02	11.02	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	11.24	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**11.02**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.19	13.19	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.20	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.16	13.16	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	13.19	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.08	13.08	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	13.16	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.08	13.08	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	13.19	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.11	13.11	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	13.43	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.11	13.11	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.12	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.88	12.88	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	13.11	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.73	12.73	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	12.88	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.59	12.59	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	12.73	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.88	12.88	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.89	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.88	12.88	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.88	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.28	12.28	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.31	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.28	12.28	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.30	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.32	13.32	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.33	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.20	13.20	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	13.32	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.32	13.32	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.32	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.23	13.23	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.24	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.16	13.16	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.16	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.15	13.15	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	13.16	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.19	8.19	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.20	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.17	8.17	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	8.19	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.09	8.09	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	8.17	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.02	8.02	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	8.09	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.53	7.53	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	8.02	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.22	7.22	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	7.53	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	6.58	6.58	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	7.22	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.18	6.18	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	6.58	9.40	HGL ok
P-253	MH-253	MH-254	3.20	5.96	5.96	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	6.18	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**5.96**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	8.13	8.13	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.14	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.10	8.10	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	8.13	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.02	8.02	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	8.10	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.02	8.02	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	8.13	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.05	8.05	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	8.37	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.05	8.05	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.06	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	7.82	7.82	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	8.05	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.67	7.67	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	7.82	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.53	7.53	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	7.67	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	7.82	7.82	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.83	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	7.82	7.82	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.82	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.22	7.22	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.25	8.38	HGL ok
P-247	DI-7	MH-248	1.00	7.22	7.22	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.24	8.39	HGL ok
P-250	DI-8	MH-251	1.00	8.26	8.26	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.27	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.14	8.14	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	8.26	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.26	8.26	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.26	10.89	HGL ok
P35	DI10	MH14	1.00	8.17	8.17	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.18	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.10	8.10	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.10	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.09	8.09	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	8.10	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.39	8.39	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.40	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.37	8.37	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	8.39	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.29	8.29	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	8.37	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.22	8.22	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	8.29	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.73	7.73	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	8.22	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.42	7.42	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	7.73	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	6.78	6.78	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	7.42	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.38	6.38	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	6.78	9.40	HGL ok
P-253	MH-253	MH-254	3.20	6.16	6.16	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	6.38	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**6.16**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	8.33	8.33	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.34	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.30	8.30	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	8.33	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.22	8.22	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	8.30	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.22	8.22	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	8.33	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.25	8.25	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	8.57	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.25	8.25	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.26	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.02	8.02	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	8.25	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.87	7.87	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	8.02	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.73	7.73	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	7.87	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.02	8.02	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.03	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.02	8.02	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.02	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.42	7.42	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.45	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	7.42	7.42	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.44	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	8.46	8.46	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.47	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.34	8.34	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	8.46	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.46	8.46	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.46	10.89	HGL ok
P35	DI10	MH14	1.00	8.37	8.37	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.38	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.30	8.30	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.30	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.29	8.29	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	8.30	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.89	11.89	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.90	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.87	11.87	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	11.89	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.79	11.79	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	11.87	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.72	11.72	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	11.79	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.23	11.23	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	11.72	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.92	10.92	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	11.23	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.28	10.28	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	10.92	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.88	9.88	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	10.28	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.66	9.66	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	9.88	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**9.66**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.83	11.83	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.84	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.80	11.80	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	11.83	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.72	11.72	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	11.80	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.72	11.72	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	11.83	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.75	11.75	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	12.07	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.75	11.75	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.76	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.52	11.52	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	11.75	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.37	11.37	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	11.52	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.23	11.23	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	11.37	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.52	11.52	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.53	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.52	11.52	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.52	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.92	10.92	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.95	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.92	10.92	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.94	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.96	11.96	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.97	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.84	11.84	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	11.96	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.96	11.96	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.96	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.87	11.87	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.88	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.80	11.80	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.80	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.79	11.79	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	11.80	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.39	12.39	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.40	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.37	12.37	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	12.39	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.29	12.29	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	12.37	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.22	12.22	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	12.29	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.73	11.73	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	12.22	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.42	11.42	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	11.73	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.78	10.78	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	11.42	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.38	10.38	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	10.78	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.16	10.16	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	10.38	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**10.16**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.33	12.33	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.34	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.30	12.30	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	12.33	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.22	12.22	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	12.30	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.22	12.22	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	12.33	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.25	12.25	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	12.57	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.25	12.25	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.26	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.02	12.02	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	12.25	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.87	11.87	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	12.02	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.73	11.73	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	11.87	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.02	12.02	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.03	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.02	12.02	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.02	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.42	11.42	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.45	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.42	11.42	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.44	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.46	12.46	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.47	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.34	12.34	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	12.46	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.46	12.46	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.46	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.37	12.37	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.38	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.30	12.30	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.30	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.29	12.29	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	12.30	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.79	12.79	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.80	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.77	12.77	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	12.79	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.69	12.69	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	12.77	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.62	12.62	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	12.69	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.13	12.13	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	12.62	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.82	11.82	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	12.13	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.18	11.18	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	11.82	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.78	10.78	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	11.18	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.56	10.56	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	10.78	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**10.56**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.73	12.73	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.74	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.70	12.70	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	12.73	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.62	12.62	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	12.70	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.62	12.62	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	12.73	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.65	12.65	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	12.97	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.65	12.65	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.66	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.42	12.42	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	12.65	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.27	12.27	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	12.42	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.13	12.13	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	12.27	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.42	12.42	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.43	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.42	12.42	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.42	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.82	11.82	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.85	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.82	11.82	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.84	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.86	12.86	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.87	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.74	12.74	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	12.86	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.86	12.86	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.86	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.77	12.77	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.78	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.70	12.70	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.70	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.69	12.69	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	12.70	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.29	13.29	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.30	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.27	13.27	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	13.29	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.19	13.19	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	13.27	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.12	13.12	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	13.19	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.63	12.63	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	13.12	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.32	12.32	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	12.63	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.68	11.68	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	12.32	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.28	11.28	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	11.68	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.06	11.06	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	11.28	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**11.06**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.23	13.23	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.24	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.20	13.20	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	13.23	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.12	13.12	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	13.20	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.12	13.12	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	13.23	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.15	13.15	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	13.47	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.15	13.15	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.16	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.92	12.92	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	13.15	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.77	12.77	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	12.92	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.63	12.63	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	12.77	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.92	12.92	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.93	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.92	12.92	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.92	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.32	12.32	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.35	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.32	12.32	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.34	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.36	13.36	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.37	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.24	13.24	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	13.36	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.36	13.36	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.36	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.27	13.27	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.28	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.20	13.20	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.20	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.19	13.19	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	13.20	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.99	13.99	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.00	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.97	13.97	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	13.99	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.89	13.89	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	13.97	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.82	13.82	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	13.89	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	13.33	13.33	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	13.82	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	13.02	13.02	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	13.33	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.38	12.38	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	13.02	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.98	11.98	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	12.38	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.76	11.76	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	11.98	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**11.76**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.93	13.93	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.94	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.90	13.90	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	13.93	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.82	13.82	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	13.90	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.82	13.82	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	13.93	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.85	13.85	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	14.17	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.85	13.85	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.86	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.62	13.62	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	13.85	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	13.47	13.47	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	13.62	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	13.33	13.33	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	13.47	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.62	13.62	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.63	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.62	13.62	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.62	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	13.02	13.02	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.05	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	13.02	13.02	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.04	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	14.06	14.06	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	14.07	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.94	13.94	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	14.06	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	14.06	14.06	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.06	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.97	13.97	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.98	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.90	13.90	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.90	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.89	13.89	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	13.90	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	14.49	14.49	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.50	8.36	HGL Too High!
P34	MH13	MH14	1.00	14.47	14.47	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	14.49	8.11	HGL Too High!
P36	MH14	MH15	1.00	14.39	14.39	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	14.47	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	14.32	14.32	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	14.39	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	13.83	13.83	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	14.32	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	13.52	13.52	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	13.83	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.88	12.88	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	13.52	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	12.48	12.48	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	12.88	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	12.26	12.26	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	12.48	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**12.26**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	14.43	14.43	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.44	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	14.40	14.40	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	14.43	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	14.32	14.32	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	14.40	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	14.32	14.32	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	14.43	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	14.35	14.35	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	14.67	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	14.35	14.35	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.36	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	14.12	14.12	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	14.35	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	13.97	13.97	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	14.12	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	13.83	13.83	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	13.97	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	14.12	14.12	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.13	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	14.12	14.12	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.12	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	13.52	13.52	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.55	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	13.52	13.52	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.54	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	14.56	14.56	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	14.57	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	14.44	14.44	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	14.56	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	14.56	14.56	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.56	10.89	HGL Too High!
P35	DI10	MH14	1.00	14.47	14.47	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.48	8.11	HGL Too High!
P40	DI12	DI11	1.00	14.40	14.40	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.40	7.19	HGL Too High!
P37	DI11	MH15	1.00	14.39	14.39	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	14.40	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	15.79	15.79	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.80	8.36	HGL Too High!
P34	MH13	MH14	1.00	15.77	15.77	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	15.79	8.11	HGL Too High!
P36	MH14	MH15	1.00	15.69	15.69	15	2.1	1.7	0	87.2	0.0009	0.08	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.09	15.77	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	15.62	15.62	15	3.3	2.7	12.7	23	0.0022	0.05	0	0.00	0.03	3.5	1.4	0.0	1.7	0.0	0	0.00	0.04	1.0	0.5	0.02	0.07	15.69	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	15.13	15.13	24	16.1	5.1	45	79	0.0043	0.34	0	0.00	0.10	8.7	6.7	35.6	3.4	0.1	90	0.12	0.29	1.0	0.5	0.14	0.49	15.62	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	14.82	14.82	36	42.8	6.1	0	33	0.0035	0.12	1	0.00	0.14	82.7	104.9	0.0	3.9	0.1	90	0.16	0.38	1.0	0.5	0.19	0.31	15.13	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	14.18	14.18	36	45.6	6.5	90	115	0.0040	0.46	2	0.00	0.16	259.7	2.8	1.4	6.1	0.2	0	0.00	0.36	1.0	0.5	0.18	0.64	14.82	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	13.78	13.78	48	47.2	3.8	90	38	0.0009	0.04	0	0.00	0.05	294.5	5.6	0.0	6.5	0.2	90	0.45	0.73	1.0	0.5	0.37	0.40	14.18	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	13.56	13.56	48	47.0	3.7	16.6	102	0.0009	0.09	0	0.00	0.05	259.7	0.0	0.0	6.1	0.2	0	0.00	0.25	1.0	0.5	0.13	0.22	13.78	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**46.3**	**3.7**	**0**	**89**	**0.0009**	**0.08**	**0**	**0.00**	**0.05**	**177.5**	**0.0**	**0.0**	**3.8**	**0.1**	**90**	**0.15**	**0.28**	**1.0**	**0.5**	**0.14**	**0.22**	**13.56**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	15.73	15.73	15	0.9	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.74	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	15.70	15.70	15	1.6	1.3	90	20	0.0005	0.01	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	15.73	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	15.62	15.62	15	2.9	2.3	90	12	0.0017	0.02	0	0.00	0.02	2.0	0.0	0.0	1.3	0.0	90	0.02	0.05	1.3	1.0	0.06	0.08	15.70	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	15.62	15.62	24	10.6	3.4	90	39	0.0019	0.07	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.12	15.73	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	15.65	15.65	30	22.3	4.5	90	98	0.0025	0.25	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.33	15.97	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	15.65	15.65	15	0.8	0.7	90	44	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.66	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	15.42	15.42	36	26.1	3.7	0	145	0.0013	0.19	0	0.00	0.05	0.6	0.0	0.0	0.7	0.0	90	0.00	0.06	1.3	0.5	0.04	0.23	15.65	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	15.27	15.27	36	27.5	3.9	0	61	0.0014	0.09	0	0.00	0.06	96.2	0.9	0.6	3.7	0.1	0	0.00	0.13	1.0	0.5	0.07	0.15	15.42	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	15.13	15.13	36	27.2	3.9	90	46	0.0014	0.07	0	0.00	0.06	106.8	0.0	0.0	3.9	0.1	0	0.00	0.14	1.0	0.5	0.07	0.14	15.27	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	15.42	15.42	15	1.0	0.8	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.43	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	15.42	15.42	15	0.9	0.7	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.42	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	14.82	14.82	15	1.8	1.5	90	23	0.0007	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	14.85	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	14.82	14.82	15	1.3	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.84	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	15.86	15.86	15	1.6	1.3	85.5	18	0.0005	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	15.87	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	15.74	15.74	15	2.6	2.1	91.5	54	0.0014	0.08	0	0.00	0.02	2.1	0.8	0.0	1.3	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.12	15.86	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	15.86	15.86	15	1.0	0.8	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.86	10.89	HGL Too High!
P35	DI10	MH14	1.00	15.77	15.77	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.78	8.11	HGL Too High!
P40	DI12	DI11	1.00	15.70	15.70	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.70	7.19	HGL Too High!
P37	DI11	MH15	1.00	15.69	15.69	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	15.70	7.09	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

RK&K

Project: South Market Street Infrastructure Improvements | Prepared by: SNR | Date: 2/23/2023 | Sheet No.: 5 of 5
County: New Castle | Checked by: TMC | Date: 3/23/2023 | Cm. No.: 20077.000
Segment: Market Street Outfall (North) | Storm Frequency: 500 -year (50-year for sumps)
4

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P33	DI24	MH13	4615	1621	6236	0.14	0.94	0.13	0.13	6.0	6.17	8.02	1.1	15	30	0.012	0.0002	0.005	4.1	5.1	3.1	0.16	6.33	4.17	4.01	Q ok
P34	MH13	MH14	1	0	1	0.00	1.00	0.00	0.13	6.0	6.33	7.99	1.1	15	44	0.012	0.0002	0.005	4.1	5.0	3.1	0.24	6.57	3.91	3.68	Q ok
P36	MH14	MH15	1	0	1	0.00	1.00	0.00	0.26	6.0	6.57	8.28	2.2	15	87	0.012	0.0010	0.005	4.1	5.0	4.0	0.37	6.93	3.57	3.12	Q ok
P-243	MH-15	MH-244	1	0	1	0.00	1.00	0.00	0.42	6.0	6.93	8.17	**3.44**	15	23	0.012	0.002422	0.0052	4.1	**5.1**	4.5	0.09	7.02	3.02	2.90	Q ok
P-244	MH-244	MH-245	1	0	1	0.00	1.00	0.00	2.08	6.0	7.02	8.14	**16.94**	24	79	0.012	0.004780	0.0089	7.3	**23.1**	8.2	0.16	7.18	2.80	2.10	Q ok
P-245	MH-245	MH-248	1	0	1	0.00	1.00	0.00	5.59	6.0	7.18	8.06	**45.03**	**36**	33	0.012	0.003884	0.0030	5.6	**39.8**	4.6	0.12	7.30	2.00	1.90	Undersizec
P-248	MH-248	MH-252	1	0	1	0.00	1.00	0.00	5.98	6.0	7.30	8.02	**47.96**	**36**	115	0.012	0.004405	0.0033	5.9	**41.5**	4.8	0.40	7.70	1.80	1.42	Undersizec
P-252	MH-252	MH-253	1	0	1	0.00	1.00	0.00	6.30	6.0	7.70	7.88	**49.63**	48	38	0.012	0.001017	0.0032	7.0	**87.4**	7.1	0.09	7.79	1.32	1.20	Q ok
P-253	MH-253	MH-254	1	0	1	0.00	1.00	0.00	6.30	6.0	7.79	7.84	**49.39**	48	102	0.012	0.001007	0.0031	6.9	**87.2**	7.1	0.24	8.03	1.10	0.78	Q ok
P-254	MH-254	OUTFALL	1	0	1	0.00	1.00	0.00	6.30	6.0	8.03	7.76	**48.92**	48	89	0.012	0.000988	0.0030	6.8	**85.7**	7.0	0.21	8.24	0.68	0.41	Q ok
P-240	DI-240	DI-241	4485	497	4982	0.11	1.00	0.11	0.11	6.0	0.00	8.51	**0.97**	15	30	0.012	0.000193	0.0050	4.0	**4.9**	3.0	0.17	6.17	3.72	3.57	Q ok
P-241	DI-241	DI-242	3403	140	3543	0.08	1.00	0.08	0.20	6.0	3.72	8.51	**1.67**	15	20	0.012	0.000566	0.0050	4.0	**4.9**	3.6	0.09	6.09	3.47	3.37	Q ok
P-242	DI-242	MH-244	6783	82	6865	0.16	1.00	0.16	0.35	6.0	3.47	8.51	**3.01**	15	12	0.012	0.001845	0.0050	4.0	**4.9**	4.2	0.05	6.05	3.27	3.21	Q ok
LIMIT FUTURE FLOW FROM A3 TO MACTH 36" PIPE CAPACITY TO MEET CLEARANCE/COVER REQUIREMENTS FOR P-245 & P-248. HOLE 48" OUTFALL																										
ASSUMED FUTURE FLOW ROUTED INTO NEW OUTFALL																										
Existing Offsite Area routed through Ex. 15" TC; Re-Routed to MH-244																										
P-Offsite	Exist Offsite	MH-244	52965	4000	56965	1.31	1.00	1.31	1.31	6.0	0.00	8.51	**11.13**	24	39	0.012	0.002061	0.0051	5.6	**17.6**	6.0	0.11	6.11	3.10	2.90	Q ok
Assumed 1/3 of Future Area 3 Routed to A St Future Trunk Line to P-261																										
P-Future A3	Addl A3	MH-261	**120000**	**0**	**120000**	2.75	1.00	2.75	2.75	6.0	0.00	8.51	**23.44**	30	98	0.012	0.002782	0.0096	8.9	**43.5**	9.0	0.18	6.18	4.20	3.26	Q ok
REMOVED 50,000SF OF A3 FROM ENTERING OUTFALL																										
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																										
P-260	DI-39	MH-261	4465	0	4465	0.10	1.00	0.10	0.10	6.0	0.00	8.51	**0.87**	15	44	0.012	0.000155	0.0032	3.2	**3.9**	2.4	0.30	6.30	3.40	3.26	Q ok
Exist Parcel Flow, Add Future A3 here																										
P-261	MH-261	MH-264	16653	1127	17780	0.41	1.00	0.41	3.27	6.0	6.30	8.40	**27.42**	36	145	0.012	0.001440	0.0030	5.6	**39.8**	6.1	0.39	6.70	3.16	2.72	Q ok
P-264	MH-264	MH-265	0	0	0	0.00	0.00	0.00	3.50	6.0	6.70	8.25	**28.89**	36	61	0.012	0.001599	0.0031	5.7	**40.3**	6.2	0.16	6.86	2.46	2.27	Q ok
P-265	MH-265	MH-245	0	0	0	0.00	0.00	0.00	3.50	6.0	6.86	8.17	**28.63**	36	*46*	0.012	0.001570	0.0037	6.2	**43.9**	6.6	0.12	6.98	2.17	2.00	Q ok
															STUB		22 LF	act length					act.	2.08		
P-262	DI-35&36	MH-264	5579	0	5579	0.13	1.00	0.13	0.13	6.0	0.00	8.51	**1.09**	15	36	0.012	0.000242	0.0031	3.2	**3.9**	2.7	0.22	6.22	3.38	3.27	Q ok
P-263	DI-37&38	MH-264	4770	0	4770	0.11	1.00	0.11	0.11	6.0	0.00	8.51	**0.93**	15	18	0.012	0.000177	0.0056	4.3	**5.2**	3.2	0.09	6.09	2.66	2.56	Q ok
Inlets Constructed in ASI																										
P-246	DI-6	MH-248	9946	0	9946	0.23	1.00	0.23	0.23	6.0	0.00	8.51	**1.94**	15	23	0.012	0.000771	0.0052	4.1	**5.1**	3.8	0.10	6.10	4.72	4.60	Q ok
P-247	DI-7	MH-248	7066	0	7066	0.16	1.00	0.16	0.16	6.0	0.00	8.51	**1.38**	15	26	0.012	0.000389	0.0046	3.9	**4.8**	3.3	0.13	6.13	4.74	4.62	Q ok
P-250	DI-8	MH-251	8718	0	8718	0.20	1.00	0.20	0.20	6.0	0.00	8.51	**1.70**	15	18	0.012	0.000592	0.0050	4.0	**4.9**	3.6	0.08	6.08	6.87	6.78	Q ok
P-251	MH-251	MH-252	0	0	0	0.00	0.00	0.00	0.33	6.0	6.09	8.47	**2.75**	15	54	0.012	0.001548	0.0078	5.0	**6.2**	4.9	0.18	6.27	6.68	6.26	Q ok
P-249	DI-9	MH-248	5442	0	5442	0.12	1.00	0.12	0.12	6.0	0.00	8.51	**1.06**	15	16	0.012	0.000231	0.0044	3.8	**4.6**	3.1	0.09	6.09	7.06	6.99	Q ok
P35	DI10	MH14	4962	681	5643	0.13	1.00	0.13	0.13	6.0	0.00	8.51	1.1	15	18	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.92	3.83	Q ok
P40	DI12	DI11	2375	125	2500	0.06	1.00	0.06	0.06	6.0	0.00	8.51	0.5	15	39	0.012	0.0000	0.005	4.0	4.9	2.4	0.27	6.27	3.67	3.47	Q ok
P37	DI11	MH15	3715	653	4368	0.10	1.00	0.10	0.16	6.0	6.27	8.40	1.3	15	18	0.012	0.0004	0.005	4.0	4.9	3.3	0.09	6.36	3.33	3.24	Q ok
	FUTURE PIPES FOR AREA 3, NOT INCLUDED IN AREA 1 SUBMITTAL																									

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.51	13.51	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.52	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.49	13.49	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	13.51	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.39	13.39	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	13.49	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.31	13.31	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	13.39	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.78	12.78	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	13.31	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.44	12.44	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	12.78	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.73	11.73	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	12.44	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.29	11.29	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	11.73	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.04	11.04	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	11.29	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**11.04**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.44	13.44	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.45	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.41	13.41	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	13.44	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.31	13.31	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	13.41	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.31	13.31	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	13.44	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.35	13.35	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	13.71	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.35	13.35	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.36	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.10	13.10	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	13.35	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.93	12.93	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	13.10	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.78	12.78	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	12.93	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.10	13.10	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.11	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.10	13.10	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.10	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.44	12.44	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.47	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.44	12.44	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	12.45	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.58	13.58	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.60	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.45	13.45	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	13.58	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.58	13.58	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.59	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.49	13.49	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.50	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.41	13.41	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.41	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.39	13.39	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	13.41	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.62	6.62	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.63	8.36	HGL ok
P34	MH13	MH14	1.00	6.60	6.60	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	6.62	8.11	HGL ok
P36	MH14	MH15	1.00	6.51	6.51	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	6.60	7.86	HGL ok
P-243	MH-15	MH-244	1.00	6.43	6.43	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	6.51	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	5.89	5.89	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	6.43	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	5.55	5.55	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	5.89	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.84	4.84	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	5.55	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.22	4.40	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	4.84	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.85	3.98	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	4.22	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.20**	**3.61**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**3.85**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	6.55	6.55	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.56	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	6.52	6.52	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	6.55	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	6.43	6.43	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	6.52	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	6.43	6.43	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	6.56	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	6.46	6.46	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	6.82	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	6.46	6.46	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.47	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	6.21	6.21	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	6.46	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	6.04	6.04	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	6.21	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	5.89	5.89	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	6.04	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	6.21	6.21	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.22	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	6.21	6.21	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.22	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	5.55	5.60	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	5.63	8.38	HGL ok
P-247	DI-7	MH-248	1.00	5.55	5.62	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	5.64	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.39	7.78	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.80	10.19	HGL ok
P-251	MH-251	MH-252	1.00	6.56	7.26	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	7.39	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.39	7.99	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.00	10.89	HGL ok
P35	DI10	MH14	1.00	6.60	6.60	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.61	8.11	HGL ok
P40	DI12	DI11	1.00	6.52	6.52	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.52	7.19	HGL Too High!
P37	DI11	MH15	1.00	6.51	6.51	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	6.52	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	6.62	6.62	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.63	8.36	HGL ok
P34	MH13	MH14	1.00	6.60	6.60	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	6.62	8.11	HGL ok
P36	MH14	MH15	1.00	6.51	6.51	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	6.60	7.86	HGL ok
P-243	MH-15	MH-244	1.00	6.43	6.43	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	6.51	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	5.89	5.89	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	6.43	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	5.55	5.55	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	5.89	7.93	HGL ok
P-248	MH-248	MH-252	2.40	4.84	4.84	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	5.55	7.35	HGL ok
P-252	MH-252	MH-253	3.20	4.22	4.40	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	4.84	9.40	HGL ok
P-253	MH-253	MH-254	3.20	3.85	3.98	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	4.22	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**3.40**	**3.61**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**3.85**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	6.55	6.55	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.56	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	6.52	6.52	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	6.55	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	6.43	6.43	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	6.52	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	6.43	6.43	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	6.56	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	6.46	6.46	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	6.82	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	6.46	6.46	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.47	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	6.21	6.21	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	6.46	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	6.04	6.04	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	6.21	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	5.89	5.89	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	6.04	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	6.21	6.21	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.22	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	6.21	6.21	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.22	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	5.55	5.60	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	5.63	8.38	HGL ok
P-247	DI-7	MH-248	1.00	5.55	5.62	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	5.64	8.39	HGL ok
P-250	DI-8	MH-251	1.00	7.39	7.78	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	7.80	10.19	HGL ok
P-251	MH-251	MH-252	1.00	6.56	7.26	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	7.39	9.00	HGL ok
P-249	DI-9	MH-248	1.00	7.39	7.99	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.00	10.89	HGL ok
P35	DI10	MH14	1.00	6.60	6.60	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	6.61	8.11	HGL ok
P40	DI12	DI11	1.00	6.52	6.52	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	6.52	7.19	HGL Too High!
P37	DI11	MH15	1.00	6.51	6.51	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	6.52	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	9.61	9.61	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.62	8.36	HGL Too High!
P34	MH13	MH14	1.00	9.59	9.59	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	9.61	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.49	9.49	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	9.59	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.41	9.41	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	9.49	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	8.88	8.88	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	9.41	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	8.54	8.54	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	8.88	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	7.83	7.83	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	8.54	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.39	7.39	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	7.83	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.14	7.14	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	7.39	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**6.90**	**6.90**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**7.14**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	9.54	9.54	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.55	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	9.51	9.51	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	9.54	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.41	9.41	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	9.51	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.41	9.41	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	9.54	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.45	9.45	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	9.81	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.45	9.45	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.46	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.20	9.20	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	9.45	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.03	9.03	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	9.20	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	8.88	8.88	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	9.03	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.20	9.20	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.21	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.20	9.20	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.20	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	8.54	8.54	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	8.57	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	8.54	8.54	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	8.55	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	9.68	9.68	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	9.70	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	9.55	9.55	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	9.68	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	9.68	9.68	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.69	10.89	HGL ok
P35	DI10	MH14	1.00	9.59	9.59	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.60	8.11	HGL Too High!
P40	DI12	DI11	1.00	9.51	9.51	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.51	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.49	9.49	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	9.51	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.11	10.11	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.12	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.09	10.09	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	10.11	8.11	HGL Too High!
P36	MH14	MH15	1.00	9.99	9.99	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	10.09	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	9.91	9.91	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	9.99	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.38	9.38	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	9.91	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.04	9.04	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	9.38	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.33	8.33	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	9.04	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	7.89	7.89	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	8.33	9.40	HGL ok
P-253	MH-253	MH-254	3.20	7.64	7.64	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	7.89	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.40**	**7.40**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**7.64**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	10.04	10.04	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.05	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.01	10.01	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	10.04	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	9.91	9.91	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	10.01	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	9.91	9.91	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	10.04	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	9.95	9.95	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	10.31	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	9.95	9.95	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.96	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	9.70	9.70	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	9.95	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.53	9.53	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	9.70	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.38	9.38	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	9.53	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	9.70	9.70	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.71	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	9.70	9.70	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.70	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.04	9.04	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	9.07	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.04	9.04	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	9.05	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.18	10.18	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.20	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.05	10.05	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	10.18	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.18	10.18	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.19	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.09	10.09	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.10	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.01	10.01	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.01	7.19	HGL Too High!
P37	DI11	MH15	1.00	9.99	9.99	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	10.01	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	10.51	10.51	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.52	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.49	10.49	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	10.51	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.39	10.39	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	10.49	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.31	10.31	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	10.39	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	9.78	9.78	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	10.31	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.44	9.44	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	9.78	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	8.73	8.73	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	9.44	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.29	8.29	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	8.73	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	8.04	8.04	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	8.29	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**7.80**	**7.80**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**8.04**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.44	10.44	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.45	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.41	10.41	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	10.44	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.31	10.31	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	10.41	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.31	10.31	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	10.44	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.35	10.35	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	10.71	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.35	10.35	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.36	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.10	10.10	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	10.35	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	9.93	9.93	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	10.10	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	9.78	9.78	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	9.93	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.10	10.10	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.11	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.10	10.10	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.10	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.44	9.44	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	9.47	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.44	9.44	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	9.45	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	10.58	10.58	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	10.60	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.45	10.45	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	10.58	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	10.58	10.58	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.59	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.49	10.49	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.50	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.41	10.41	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.41	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.39	10.39	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	10.41	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ftnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.01	11.01	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.02	8.36	HGL Too High!
P34	MH13	MH14	1.00	10.99	10.99	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	11.01	8.11	HGL Too High!
P36	MH14	MH15	1.00	10.89	10.89	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	10.99	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	10.81	10.81	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	10.89	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.28	10.28	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	10.81	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	9.94	9.94	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	10.28	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.23	9.23	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	9.94	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	8.79	8.79	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	9.23	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	8.54	8.54	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	8.79	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**8.30**	**8.30**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**8.54**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	10.94	10.94	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.95	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	10.91	10.91	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	10.94	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	10.81	10.81	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	10.91	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	10.81	10.81	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	10.94	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	10.85	10.85	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	11.21	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	10.85	10.85	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.86	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	10.60	10.60	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	10.85	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	10.43	10.43	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	10.60	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.28	10.28	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	10.43	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	10.60	10.60	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.61	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	10.60	10.60	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.60	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	9.94	9.94	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	9.97	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	9.94	9.94	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	9.95	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.08	11.08	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.10	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	10.95	10.95	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	11.08	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.08	11.08	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.09	10.89	HGL Too High!
P35	DI10	MH14	1.00	10.99	10.99	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.00	8.11	HGL Too High!
P40	DI12	DI11	1.00	10.91	10.91	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.91	7.19	HGL Too High!
P37	DI11	MH15	1.00	10.89	10.89	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	10.91	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ftnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	11.71	11.71	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.72	8.36	HGL Too High!
P34	MH13	MH14	1.00	11.69	11.69	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	11.71	8.11	HGL Too High!
P36	MH14	MH15	1.00	11.59	11.59	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	11.69	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.51	11.51	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	11.59	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	10.98	10.98	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	11.51	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	10.64	10.64	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	10.98	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	9.93	9.93	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	10.64	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.49	9.49	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	9.93	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.24	9.24	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	9.49	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.00**	**9.00**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**9.24**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	11.64	11.64	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.65	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	11.61	11.61	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	11.64	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.51	11.51	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	11.61	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.51	11.51	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	11.64	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.55	11.55	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	11.91	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.55	11.55	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.56	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.30	11.30	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	11.55	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.13	11.13	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	11.30	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	10.98	10.98	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	11.13	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.30	11.30	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.31	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.30	11.30	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.30	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	10.64	10.64	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	10.67	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	10.64	10.64	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	10.65	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	11.78	11.78	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	11.80	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	11.65	11.65	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	11.78	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	11.78	11.78	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.79	10.89	HGL Too High!
P35	DI10	MH14	1.00	11.69	11.69	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.70	8.11	HGL Too High!
P40	DI12	DI11	1.00	11.61	11.61	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.61	7.19	HGL Too High!
P37	DI11	MH15	1.00	11.59	11.59	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	11.61	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.21	12.21	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.22	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.19	12.19	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	12.21	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.09	12.09	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	12.19	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.01	12.01	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	12.09	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.48	11.48	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	12.01	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.14	11.14	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	11.48	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.43	10.43	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	11.14	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.99	9.99	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	10.43	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.74	9.74	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	9.99	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.50**	**9.50**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**9.74**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.14	12.14	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.15	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.11	12.11	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	12.14	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.01	12.01	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	12.11	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.01	12.01	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	12.14	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.05	12.05	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	12.41	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.05	12.05	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.06	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.80	11.80	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	12.05	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.63	11.63	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	11.80	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.48	11.48	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	11.63	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.80	11.80	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.81	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.80	11.80	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.80	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.14	11.14	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.17	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.14	11.14	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	11.15	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.28	12.28	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.30	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.15	12.15	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	12.28	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.28	12.28	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.29	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.19	12.19	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.20	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.11	12.11	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.11	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.09	12.09	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	12.11	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.51	13.51	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.52	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.49	13.49	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	13.51	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.39	13.39	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	13.49	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.31	13.31	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	13.39	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.78	12.78	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	13.31	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.44	12.44	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	12.78	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.73	11.73	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	12.44	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.29	11.29	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	11.73	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.04	11.04	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	11.29	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.80**	**10.80**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**11.04**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.44	13.44	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.45	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.41	13.41	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	13.44	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.31	13.31	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	13.41	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.31	13.31	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	13.44	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.35	13.35	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	13.71	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.35	13.35	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.36	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.10	13.10	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	13.35	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.93	12.93	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	13.10	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.78	12.78	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	12.93	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.10	13.10	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.11	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.10	13.10	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.10	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.44	12.44	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.47	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.44	12.44	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	12.45	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.58	13.58	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.60	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.45	13.45	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	13.58	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.58	13.58	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.59	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.49	13.49	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.50	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.41	13.41	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.41	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.39	13.39	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	13.41	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.45	8.45	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.46	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.43	8.43	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	8.45	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.33	8.33	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	8.43	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.25	8.25	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	8.33	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.72	7.72	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	8.25	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.38	7.38	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	7.72	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	6.67	6.67	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	7.38	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.23	6.23	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	6.67	9.40	HGL ok
P-253	MH-253	MH-254	3.20	5.98	5.98	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	6.23	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.74**	**5.74**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**5.98**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	8.38	8.38	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.39	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.35	8.35	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	8.38	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.25	8.25	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	8.35	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.25	8.25	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	8.38	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.29	8.29	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	8.65	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.29	8.29	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.30	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.04	8.04	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	8.29	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	7.87	7.87	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	8.04	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.72	7.72	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	7.87	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.04	8.04	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.05	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.04	8.04	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.04	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.38	7.38	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	7.41	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	7.38	7.38	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	7.39	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	8.52	8.52	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.54	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.39	8.39	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	8.52	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.52	8.52	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.53	10.89	HGL ok
P35	DI10	MH14	1.00	8.43	8.43	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.44	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.35	8.35	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.35	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.33	8.33	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	8.35	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling Inflow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	8.65	8.65	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.66	8.36	HGL Too High!
P34	MH13	MH14	1.00	8.63	8.63	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	8.65	8.11	HGL Too High!
P36	MH14	MH15	1.00	8.53	8.53	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	8.63	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	8.45	8.45	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	8.53	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	7.92	7.92	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	8.45	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	7.58	7.58	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	7.92	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	6.87	6.87	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	7.58	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	6.43	6.43	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	6.87	9.40	HGL ok
P-253	MH-253	MH-254	3.20	6.18	6.18	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	6.43	9.40	HGL ok
P-254	**MH-254**	**OUTFALL**	**3.20**	**5.94**	**5.94**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**6.18**	**8.70**	**HGL ok**
P-240	DI-240	DI-241	1.00	8.58	8.58	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.59	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	8.55	8.55	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	8.58	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	8.45	8.45	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	8.55	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	8.45	8.45	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	8.58	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	8.49	8.49	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	8.85	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	8.49	8.49	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.50	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	8.24	8.24	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	8.49	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	8.07	8.07	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	8.24	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	7.92	7.92	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	8.07	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	8.24	8.24	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.25	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	8.24	8.24	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.24	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	7.58	7.58	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	7.61	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	7.58	7.58	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	7.59	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	8.72	8.72	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	8.74	10.19	HGL ok
P-251	MH-251	MH-252	1.00	8.59	8.59	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	8.72	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	8.72	8.72	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.73	10.89	HGL ok
P35	DI10	MH14	1.00	8.63	8.63	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.64	8.11	HGL Too High!
P40	DI12	DI11	1.00	8.55	8.55	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.55	7.19	HGL Too High!
P37	DI11	MH15	1.00	8.53	8.53	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	8.55	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.15	12.15	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.16	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.13	12.13	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	12.15	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.03	12.03	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	12.13	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	11.95	11.95	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	12.03	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.42	11.42	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	11.95	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.08	11.08	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	11.42	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.37	10.37	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	11.08	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	9.93	9.93	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	10.37	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	9.68	9.68	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	9.93	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.44**	**9.44**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**9.68**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.08	12.08	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.09	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.05	12.05	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	12.08	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	11.95	11.95	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	12.05	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	11.95	11.95	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	12.08	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	11.99	11.99	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	12.35	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	11.99	11.99	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.00	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	11.74	11.74	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	11.99	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	11.57	11.57	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	11.74	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.42	11.42	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	11.57	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	11.74	11.74	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.75	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	11.74	11.74	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.74	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.08	11.08	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.11	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.08	11.08	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	11.09	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.22	12.22	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.24	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.09	12.09	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	12.22	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.22	12.22	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.23	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.13	12.13	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.14	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.05	12.05	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.05	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.03	12.03	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	12.05	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignment add Hc = 0.002*O*V_o^2/2g	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	12.65	12.65	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.66	8.36	HGL Too High!
P34	MH13	MH14	1.00	12.63	12.63	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	12.65	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.53	12.53	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	12.63	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.45	12.45	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	12.53	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	11.92	11.92	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	12.45	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.58	11.58	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	11.92	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	10.87	10.87	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	11.58	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.43	10.43	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	10.87	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.18	10.18	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	10.43	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**9.94**	**9.94**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**10.18**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.58	12.58	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.59	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.55	12.55	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	12.58	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.45	12.45	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	12.55	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.45	12.45	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	12.58	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.49	12.49	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	12.85	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.49	12.49	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.50	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.24	12.24	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	12.49	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.07	12.07	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	12.24	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	11.92	11.92	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	12.07	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.24	12.24	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.25	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.24	12.24	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.24	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.58	11.58	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	11.61	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.58	11.58	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	11.59	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	12.72	12.72	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	12.74	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.59	12.59	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	12.72	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	12.72	12.72	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.73	10.89	HGL Too High!
P35	DI10	MH14	1.00	12.63	12.63	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.64	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.55	12.55	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.55	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.53	12.53	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	12.55	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.05	13.05	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.06	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.03	13.03	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	13.05	8.11	HGL Too High!
P36	MH14	MH15	1.00	12.93	12.93	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	13.03	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	12.85	12.85	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	12.93	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.32	12.32	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	12.85	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	11.98	11.98	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	12.32	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.27	11.27	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	11.98	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	10.83	10.83	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	11.27	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	10.58	10.58	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	10.83	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.34**	**10.34**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**10.58**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	12.98	12.98	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.99	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	12.95	12.95	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	12.98	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	12.85	12.85	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	12.95	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	12.85	12.85	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	12.98	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	12.89	12.89	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	13.25	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	12.89	12.89	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.90	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	12.64	12.64	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	12.89	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.47	12.47	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	12.64	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.32	12.32	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	12.47	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	12.64	12.64	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.65	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	12.64	12.64	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.64	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	11.98	11.98	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.01	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	11.98	11.98	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	11.99	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.12	13.12	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.14	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	12.99	12.99	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	13.12	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.12	13.12	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.13	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.03	13.03	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.04	8.11	HGL Too High!
P40	DI12	DI11	1.00	12.95	12.95	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.95	7.19	HGL Too High!
P37	DI11	MH15	1.00	12.93	12.93	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	12.95	7.09	HGL Too High!

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County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	13.55	13.55	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.56	8.36	HGL Too High!
P34	MH13	MH14	1.00	13.53	13.53	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	13.55	8.11	HGL Too High!
P36	MH14	MH15	1.00	13.43	13.43	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	13.53	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	13.35	13.35	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	13.43	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	12.82	12.82	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	13.35	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	12.48	12.48	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	12.82	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	11.77	11.77	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	12.48	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	11.33	11.33	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	11.77	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.08	11.08	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	11.33	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**10.84**	**10.84**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**11.08**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	13.48	13.48	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.49	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	13.45	13.45	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	13.48	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	13.35	13.35	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	13.45	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	13.35	13.35	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	13.48	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	13.39	13.39	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	13.75	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	13.39	13.39	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.40	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.14	13.14	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	13.39	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	12.97	12.97	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	13.14	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	12.82	12.82	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	12.97	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.14	13.14	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.15	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.14	13.14	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.14	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	12.48	12.48	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	12.51	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	12.48	12.48	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	12.49	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	13.62	13.62	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	13.64	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	13.49	13.49	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	13.62	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	13.62	13.62	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.63	10.89	HGL Too High!
P35	DI10	MH14	1.00	13.53	13.53	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.54	8.11	HGL Too High!
P40	DI12	DI11	1.00	13.45	13.45	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.45	7.19	HGL Too High!
P37	DI11	MH15	1.00	13.43	13.43	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	13.45	7.09	HGL Too High!

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RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved alignt.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	14.25	14.25	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.26	8.36	HGL Too High!
P34	MH13	MH14	1.00	14.23	14.23	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	14.25	8.11	HGL Too High!
P36	MH14	MH15	1.00	14.13	14.13	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	14.23	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	14.05	14.05	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	14.13	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	13.52	13.52	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	14.05	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	13.18	13.18	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	13.52	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.47	12.47	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	13.18	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	12.03	12.03	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	12.47	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	11.78	11.78	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	12.03	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**11.54**	**11.54**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**11.78**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	14.18	14.18	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.19	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	14.15	14.15	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	14.18	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	14.05	14.05	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	14.15	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	14.05	14.05	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	14.18	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	14.09	14.09	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	14.45	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	14.09	14.09	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.10	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	13.84	13.84	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	14.09	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	13.67	13.67	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	13.84	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	13.52	13.52	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	13.67	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	13.84	13.84	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.85	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	13.84	13.84	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.84	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	13.18	13.18	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.21	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	13.18	13.18	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	13.19	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	14.32	14.32	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	14.34	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	14.19	14.19	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	14.32	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	14.32	14.32	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.33	10.89	HGL Too High!
P35	DI10	MH14	1.00	14.23	14.23	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.24	8.11	HGL Too High!
P40	DI12	DI11	1.00	14.15	14.15	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.15	7.19	HGL Too High!
P37	DI11	MH15	1.00	14.13	14.13	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	14.15	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvature	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	14.75	14.75	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.76	8.36	HGL Too High!
P34	MH13	MH14	1.00	14.73	14.73	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	14.75	8.11	HGL Too High!
P36	MH14	MH15	1.00	14.63	14.63	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	14.73	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	14.55	14.55	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	14.63	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	14.02	14.02	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	14.55	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	13.68	13.68	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	14.02	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	12.97	12.97	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	13.68	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	12.53	12.53	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	12.97	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	12.28	12.28	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	12.53	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**12.04**	**12.04**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**12.28**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	14.68	14.68	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.69	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	14.65	14.65	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	14.68	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	14.55	14.55	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	14.65	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	14.55	14.55	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	14.68	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	14.59	14.59	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	14.95	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																														
P-260	DI-39	MH-261	1.00	14.59	14.59	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.60	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	14.34	14.34	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	14.59	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	14.17	14.17	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	14.34	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	14.02	14.02	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	14.17	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	14.34	14.34	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.35	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	14.34	14.34	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.34	6.35	HGL Too High!
Inlets Constructed in ASI																														
P-246	DI-6	MH-248	1.00	13.68	13.68	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	13.71	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	13.68	13.68	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	13.69	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	14.82	14.82	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	14.84	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	14.69	14.69	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	14.82	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	14.82	14.82	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.83	10.89	HGL Too High!
P35	DI10	MH14	1.00	14.73	14.73	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.74	8.11	HGL Too High!
P40	DI12	DI11	1.00	14.65	14.65	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.65	7.19	HGL Too High!
P37	DI11	MH15	1.00	14.63	14.63	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	14.65	7.09	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

RK&K

Project:	South Market Street Infrastructure Improvements	Prepared by:	SNR	Date:	2/23/23	Sheet No.:	5 of 5
County:	New Castle	Checked by:	TMC	Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Outfall (North)	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, ltlnk to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel. $V_o=Q_o/A$	Skew angle vs.	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align.: add Hc = $0.002*O*V_o^2/2g$	Contraction Loss	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Q*V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for Inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB staping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P33	DI24	MH13	1.00	16.05	16.05	15	1.1	0.9	90	30.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.06	8.36	HGL Too High!
P34	MH13	MH14	1.00	16.03	16.03	15	1.1	0.9	0	44.2	0.0002	0.01	0	0.00	0.00	0.9	0.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.02	16.05	8.11	HGL Too High!
P36	MH14	MH15	1.00	15.93	15.93	15	2.2	1.8	0	87.2	0.0010	0.09	0	0.00	0.01	0.9	0.0	0.0	0.9	0.0	0	0.00	0.02	1.3	0.5	0.01	0.10	16.03	7.86	HGL Too High!
P-243	MH-15	MH-244	1.00	15.85	15.85	15	3.4	2.8	12.7	23	0.0024	0.06	0	0.00	0.03	3.9	1.4	0.0	1.8	0.0	0	0.00	0.05	1.0	0.5	0.02	0.08	15.93	7.17	HGL Too High!
P-244	MH-244	MH-245	1.60	15.32	15.32	24	16.9	5.4	45	79	0.0048	0.38	0	0.00	0.11	9.7	7.4	39.4	3.5	0.1	90	0.14	0.32	1.0	0.5	0.16	0.54	15.85	7.35	HGL Too High!
P-245	MH-245	MH-248	2.40	14.98	14.98	36	45.0	6.4	0	33	0.0039	0.13	1	0.00	0.16	91.4	116.0	0.0	4.1	0.1	90	0.18	0.43	1.0	0.5	0.21	0.34	15.32	7.93	HGL Too High!
P-248	MH-248	MH-252	2.40	14.27	14.27	36	48.0	6.8	90	115	0.0044	0.51	2	0.00	0.18	286.8	3.1	1.6	6.4	0.2	0	0.00	0.40	1.0	0.5	0.20	0.71	14.98	7.35	HGL Too High!
P-252	MH-252	MH-253	3.20	13.83	13.83	48	49.6	3.9	90	38	0.0010	0.04	0	0.00	0.06	325.3	6.2	0.0	6.8	0.3	90	0.50	0.81	1.0	0.5	0.41	0.44	14.27	9.40	HGL Too High!
P-253	MH-253	MH-254	3.20	13.58	13.58	48	49.4	3.9	16.6	102	0.0010	0.10	0	0.00	0.06	286.8	0.0	0.0	6.4	0.2	0	0.00	0.28	1.0	0.5	0.14	0.24	13.83	9.40	HGL Too High!
P-254	**MH-254**	**OUTFALL**	**3.20**	**13.34**	**13.34**	**48**	**48.9**	**3.9**	**0**	**89**	**0.0010**	**0.09**	**0**	**0.00**	**0.06**	**196.0**	**0.0**	**0.0**	**3.9**	**0.1**	**90**	**0.17**	**0.31**	**1.0**	**0.5**	**0.16**	**0.24**	**13.58**	**8.70**	**HGL Too High**
P-240	DI-240	DI-241	1.00	15.98	15.98	15	1.0	0.8	90	30	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.99	6.85	HGL Too High!
P-241	DI-241	DI-242	1.00	15.95	15.95	15	1.7	1.4	90	20	0.0006	0.01	0	0.00	0.01	0.8	0.0	0.0	0.8	0.0	90	0.01	0.02	1.3	1.0	0.02	0.03	15.98	6.98	HGL Too High!
P-242	DI-242	MH-244	1.00	15.85	15.85	15	3.0	2.4	90	12	0.0018	0.02	0	0.00	0.02	2.3	0.0	0.0	1.4	0.0	90	0.02	0.05	1.3	1.0	0.07	0.09	15.95	7.07	HGL Too High!
P-Offsite	Exist Offsite	MH-244	1.60	15.85	15.85	24	11.1	3.5	90	39	0.0021	0.08	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.13	15.98	7.07	HGL Too High!
P-Future A3	Addl A3	MH-261	2.00	15.89	15.89	30	23.4	4.8	90	98	0.0028	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.36	16.25	7.20	HGL Too High!
A-Street East (Future Flow)-Assumes Area 3 will reroute existing drainage into P-265 stub																															
P-260	DI-39	MH-261	1.00	15.89	15.89	15	0.9	0.7	90	44	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.90	6.78	HGL Too High!
P-261	MH-261	MH-264	2.40	15.64	15.64	36	27.4	3.9	0	145	0.0014	0.21	0	0.00	0.06	0.6	0.0	0.0	0.7	0.0	90	0.01	0.07	1.3	0.5	0.04	0.25	15.89	6.80	HGL Too High!
P-264	MH-264	MH-265	2.40	15.47	15.47	36	28.9	4.1	0	61	0.0016	0.10	0	0.00	0.06	106.4	1.0	0.7	3.9	0.1	0	0.00	0.15	1.0	0.5	0.07	0.17	15.64	6.48	HGL Too High!
P-265	MH-265	MH-245	2.40	15.32	15.32	36	28.6	4.1	90	46	0.0016	0.07	0	0.00	0.06	118.1	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.15	15.47	6.82	HGL Too High!
P-262	DI-35&36	MH-264	1.00	15.64	15.64	15	1.1	0.9	90	36	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.65	7.04	HGL Too High!
P-263	DI-37&38	MH-264	1.00	15.64	15.64	15	0.9	0.8	90	18	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.64	6.35	HGL Too High!
Inlets Constructed in ASI																															
P-246	DI-6	MH-248	1.00	14.98	14.98	15	1.9	1.6	90	23	0.0008	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	15.01	8.38	HGL Too High!
P-247	DI-7	MH-248	1.00	14.98	14.98	15	1.4	1.1	90	26	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.99	8.39	HGL Too High!
P-250	DI-8	MH-251	1.00	16.12	16.12	15	1.7	1.4	85.5	18	0.0006	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	16.14	10.19	HGL Too High!
P-251	MH-251	MH-252	1.00	15.99	15.99	15	2.8	2.2	91.5	54	0.0015	0.08	0	0.00	0.02	2.4	0.9	0.0	1.4	0.0	85.5	0.02	0.05	1.0	1.0	0.05	0.13	16.12	9.00	HGL Too High!
P-249	DI-9	MH-248	1.00	16.12	16.12	15	1.1	0.9	93.9	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.13	10.89	HGL Too High!
P35	DI10	MH14	1.00	16.03	16.03	15	1.1	0.9	90	18.1	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.04	8.11	HGL Too High!
P40	DI12	DI11	1.00	15.95	15.95	15	0.5	0.4	0	39.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.95	7.19	HGL Too High!
P37	DI11	MH15	1.00	15.93	15.93	15	1.3	1.1	90	18.4	0.0004	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	0	0.00	0.01	1.3	1.0	0.01	0.01	15.95	7.09	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 1 -year (50-year for sumps)

Location No.	From	To	Impervious Area, C = 0.95 to Inlet A_{imp} ft^2	Pervious Area, C = 0.18 to Inlet A_{perv} ft^2	Total Area A_{total} ft^2	Incremental Area Δ A Acres	Runoff Coefficient C	C x Δ A CxΔA Acres	Σ (C x Δ A) Σ CA Acres	Inlet Time T_c min	Time to Upper End T_c min	Rainfall Intensity I in/hr	Design Discharge Q cfs	Pipe Diameter D in	Length of Pipe L ft	Roughness Coefficient n	Friction Slope S_f ft/ft	Pipe Slope S_o ft/ft	Full Velocity V_{full} fps	Full Capacity Q_{full} cfs	Actual Velocity V_{act} fps	Flow Time In Pipe T_t min	Time to Lower End T_t min	Invert at Upper End Inv Up ft	Invert at Lower End Inv Dn ft	Capacity Check
MARKET ST RIVER WEST OUTFALL																										
SOUTH SECTION TO 24"																										
P4	DI15	MH1	3244	1216	4460	0.10	0.74	0.08	0.08	6.0	0.00	4.01	0.3	15	27.3	0.012	0.000019	0.005	4.1	5.0	2.0	0.23	6.23	4.49	4.35	Q ok
P5	MH1	MH2	1	0	1	0.00	0.95	0.00	0.16	6.0	6.23	3.98	0.6	18	82.7	0.012	0.000029	0.005	4.5	8.0	2.7	0.51	6.73	4.25	3.84	Q ok
P7	MH2	MH3	1	0	1	0.00	0.95	0.00	0.23	6.0	6.73	3.89	0.9	18	73.8	0.012	0.000064	0.005	4.6	8.1	2.7	0.45	7.18	3.81	3.44	Q ok
P10	MH3	MH4	1	0	1	0.00	0.95	0.00	0.43	6.0	7.18	3.81	1.6	18	53.7	0.012	0.000208	0.005	4.6	8.1	3.4	0.26	7.44	3.34	3.07	Q ok
P13	MH4	MH5	1	0	1	0.00	0.95	0.00	0.75	6.0	7.44	3.78	2.8	18	59.3	0.012	0.000613	0.005	4.3	7.7	3.9	0.25	7.70	2.97	2.70	Q ok
P15	MH5	MH20	1	0	1	0.00	0.95	0.00	1.13	6.0	7.70	3.73	4.2	24	104.1	0.012	0.000295	0.020	11.1	34.8	6.6	0.26	7.96	2.60	0.50	Q ok
P6	DI16	MH2	3400	1275	4675	0.11	0.74	0.08	0.08	6.0	0.00	4.01	0.3	15	29.3	0.012	0.000021	0.005	4.1	5.0	2.0	0.24	6.24	4.06	3.91	Q ok
P9	DI3	MH3	4110	3259	7369	0.17	0.61	0.10	0.10	6.0	0.00	4.01	0.4	15	18.3	0.012	0.000035	0.005	4.0	4.9	2.4	0.13	6.13	3.68	3.59	Q ok
P8	DI17	MH3	3878	2100	5978	0.14	0.68	0.09	0.09	6.0	0.00	4.01	0.4	15	31.3	0.012	0.000029	0.005	4.2	5.2	2.1	0.25	6.25	3.71	3.54	Q ok
P12	DI4	MH4	7109	2561	9670	0.22	0.75	0.17	0.17	6.0	0.00	6.73	1.1	15	20.1	0.012	0.000254	0.005	4.0	4.9	3.3	0.10	6.10	3.48	3.38	Q ok
P11	DI18	MH4	6435	2210	8645	0.20	0.75	0.15	0.15	6.0	0.00	6.70	1.0	15	28.4	0.012	0.000205	0.005	4.1	5.1	3.1	0.15	6.15	3.48	3.33	Q ok
P14	DI5	MH5	4974	2549	7523	0.17	0.69	0.12	0.12	6.0	0.00	4.01	0.5	15	22.6	0.012	0.000047	0.005	4.0	4.9	2.4	0.16	6.16	3.68	3.57	Q ok
P18	DI6	MH6	6937	1863	8800	0.20	0.79	0.16	0.16	6.0	0.00	4.01	0.6	15	38.0	0.012	0.000083	0.005	4.0	4.9	2.8	0.22	6.22	4.57	4.38	Q ok
P16	MH6	MH5	1	0	1	0.00	0.95	0.00	0.27	6.0	6.22	3.98	1.1	18	40.0	0.012	0.000086	0.011	6.8	12.1	4.1	0.16	6.39	3.77	3.32	Q ok
P17	DI19	MH6	4542	1703	6245	0.14	0.74	0.11	0.11	6.0	0.00	4.01	0.4	15	33.0	0.012	0.000037	0.005	4.0	4.9	2.4	0.23	6.23	4.19	4.02	Q ok
NORTH SECTION TO 24"																										
P32	DI23	MH12	5495	1914	7409	0.17	0.75	0.13	0.13	6.0	0.00	4.01	0.5	15	33.31	0.012	0.0001	0.005	4.1	5.0	2.4	0.23	6.23	3.98	3.81	Q ok
P31	DI9	MH12	4483	551	5034	0.12	0.87	0.10	0.10	6.0	0.00	4.01	0.4	15	18.3	0.012	0.0000	0.005	4.0	4.9	2.4	0.13	6.13	3.86	3.77	Q ok
P30	MH12	MH11	1	0	1	0.00	0.95	0.00	0.23	6.0	6.23	3.98	0.9	18	50.1	0.012	0.0001	0.005	4.5	8.0	2.7	0.31	6.53	3.67	3.42	Q ok
P27	MH11	MH10	1	0	1	0.00	0.95	0.00	0.47	6.0	6.53	3.93	1.9	18	73.2	0.012	0.0003	0.005	4.6	8.1	3.8	0.32	6.86	3.39	3.02	Q ok
P25	MH10	MH9	1	0	1	0.00	0.95	0.00	0.54	6.0	6.86	3.86	2.1	24	69.68	0.012	0.0001	0.006	6.3	19.7	3.8	0.31	7.17	2.92	2.47	Q ok
P22	MH9	MH8	1	0	1	0.00	0.95	0.00	0.68	6.0	7.17	3.81	2.6	24	108.3	0.012	0.0001	0.005	5.5	17.3	3.9	0.47	7.63	2.47	1.93	Q ok
P20	MH8	MH21	1	0	1	0.00	0.95	0.00	0.90	6.0	7.63	3.74	3.4	24	57.3	0.012	0.0002	0.021	11.4	35.8	6.8	0.14	7.77	1.65	0.43	Q ok
P21	MH21	EXMH1	1	0	1	0.00	0.95	0.00	0.90	6.0	7.77	3.71	3.3	24	11.3	0.012	0.0002	0.005	5.7	17.9	4.3	0.04	7.82	0.33	0.27	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 1 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P47	DI35	EXMH1	29988	0	29988	0.69	0.95	0.65	0.65	6.0	0.00	4.01	2.6	18	7.75	0.012	0.0005	0.008	5.8	10.3	4.8	0.03	6.03	-0.50	-0.56	Q ok
P-80	DI-80	MH-08	9967	0	9967	0.23	0.95	0.22	0.22	6.0	0.00	4.01	0.9	15	49	0.012	0.0002	0.009	5.5	6.8	3.9	0.21	6.21	4.53	4.07	Q ok
P52	TDI50	DI22	8815	0	8815	0.20	0.95	0.19	0.19	6.0	0.00	4.01	0.8	8	17	0.012	0.0035	0.010	3.8	1.3	3.9	0.07	6.07	3.92	3.75	Q ok
P51	STUB	DI22	21322	0	21322	0.49	0.95	0.47	0.47	6.0	0.00	4.01	1.9	15	10.02	0.012	0.0007	0.005	4.0	4.9	3.7	0.05	6.05	3.79	3.74	Q ok
P28	DI22	MH11	5555	1955	7510	0.17	0.75	0.13	0.13	6.0	0.00	4.01	0.5	15	30.3	0.012	0.0001	0.005	4.0	4.9	2.4	0.21	6.21	3.64	3.49	Q ok
P29	DI8	MH11	5120	570	5690	0.13	0.87	0.11	0.11	6.0	0.00	4.01	0.5	15	18.3	0.012	0.0000	0.005	4.0	4.9	2.4	0.13	6.13	3.64	3.55	Q ok
P26	DI21	MH10	2755	930	3685	0.08	0.76	0.06	0.06	6.0	0.00	4.01	0.3	15	18.3	0.012	0.0000	0.005	4.0	4.9	2.0	0.16	6.16	4.02	3.93	Q ok
P23	DI20	MH9	3213	1102	4315	0.10	0.75	0.07	0.07	6.0	0.00	4.01	0.3	15	29.3	0.012	0.0000	0.005	4.0	4.9	2.0	0.25	6.25	4.53	4.38	Q ok
P24	DI7	MH9	3164	527	3691	0.08	0.84	0.07	0.07	6.0	0.00	4.01	0.3	15	28.02	0.012	0.0000	0.005	4.0	4.9	2.0	0.24	6.24	4.38	4.24	Q ok
SOUTH SECTION LOW TRUNK TO 24" OUTFALL																										
CRB-P72	CRB-DI72	CRB-MH-74	6086	0	6086	0.14	0.95	0.13	0.13	6.0	0.00	4.01	0.5	15	16	0.012	0.0001	0.019	7.8	9.6	3.8	0.07	6.07	2.60	2.30	Q ok
CRB-P73	CRB-DI73	CRB-MH-74	7042	0	7042	0.16	0.95	0.15	0.15	6.0	0.00	4.01	0.6	15	34	0.012	0.0001	0.005	4.0	4.9	2.4	0.23	6.23	1.92	1.75	Q ok
CRB-P74	CRB-MH-74	CRB-MH-67	1	0	1	0.00	0.95	0.00	0.29	6.0	6.23	3.98	1.1	15	154	0.012	0.0003	0.005	4.1	5.1	3.1	0.83	7.06	1.65	0.84	Q ok
EXP2	CRB-MH-67	EXMH3	1	0	1	0.00	0.95	0.00	0.70	6.0	7.06	3.83	2.7	15	23	0.013	0.0017	***0.003***	***2.7***	3.3	3.0	0.13	7.19	-1.14	-1.20	Q ok
EXP3	EXMH3	EXMH4	1	0	1	0.00	0.95	0.00	0.85	6.0	7.19	3.81	3.2	15	78	0.013	0.0025	***0.003***	***2.7***	3.3	3.1	0.42	7.60	-1.20	-1.40	Q ok
EXP4	EXMH4	EXMH5	1	0	1	0.00	0.95	0.00	0.85	6.0	7.60	3.74	3.2	15	54	0.013	0.0024	***0.003***	***2.7***	3.3	3.1	0.29	7.89	-1.40	-1.54	Q ok
EXP5	EXMH5	EXMH6	1	0	1	0.00	0.95	0.00	1.89	6.0	7.89	3.69	7.0	15	263	0.013	0.0116	***0.003***	***2.7***	3.3	2.2	2.00	9.89	-1.54	-2.22	Undersized!
EXP6	EXMH6	EXMH7	1	0	1	0.00	0.95	0.00	2.88	6.0	9.89	3.36	9.7	15	96	0.013	0.0224	***0.003***	***2.7***	3.3	2.2	0.73	10.62	-2.22	-2.47	Undersized!
EXP7	EXMH7	EXMH8	1	0	1	0.00	0.95	0.00	2.88	6.0	10.62	3.27	9.4	15	175	0.013	0.0213	***0.003***	***2.7***	3.3	2.2	1.33	11.95	-2.47	-2.92	Undersized!
EXP8	EXMH8	EXMH9	1	0	1	0.00	0.95	0.00	2.88	6.0	11.95	3.13	9.0	24	41	0.013	0.0016	0.009	6.8	21.4	6.3	0.11	12.06	-2.92	-3.29	Q ok
EXP9	EXMH9	EXMH10	1	0	1	0.00	0.95	0.00	4.43	6.0	12.06	3.10	13.8	24	124	0.013	0.0037	0.009	6.8	21.4	7.3	0.28	12.34	-3.29	-4.40	Q ok
EXP10	EXMH10	EXMH11	1	0	1	0.00	0.95	0.00	5.57	6.0	12.34	3.08	17.2	24	8	0.013	0.0057	***0.001***	***2.7***	8.5	2.2	0.06	12.40	-4.40	-4.41	Undersized!
EXP11	EXMH11	EXMH12	1	0	1	0.00	0.95	0.00	5.57	6.0	12.40	3.07	17.1	24	252	0.013	0.0057	***0.001***	***2.7***	8.5	2.2	1.90	14.30	-4.41	-4.76	Undersized!
EXP12	EXMH12	EXMH13	1	0	1	0.00	0.95	0.00	5.57	6.0	14.30	2.86	15.9	24	221	0.013	0.0049	***0.001***	***2.7***	8.5	2.2	1.67	15.97	-4.76	-5.07	Undersized!
EXP13	**EXMH13**	**OUTFALL**	**1**	**0**	**1**	**0.00**	0.95	**0.00**	**5.57**	**6.0**	**15.97**	2.72	15.1	**24**	**98**	**0.013**	**0.0045**	***0.001***	***2.7***	**8.5**	**2.2**	**0.74**	**16.71**	**-5.07**	**-5.21**	**Undersized!**
ROOF	COLLINS	MSS DI-13	8875	0	8875	0.20	0.95	0.19	0.19	6.0	0.00	4.01	0.8	4	16	0.012	0.1419	0.019	3.2	0.3	2.7	0.10	6.10	2.60	2.30	Undersized!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 1 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
CRB-P75	TD-03	MSS DI-13	2341	0	2341	0.05	0.95	0.05	0.05	6.0	0.00	4.01	**0.20**	8	33	0.011	0.000206	0.0348	7.6	**2.7**	4.6	0.12	6.12	4.57	3.42	Q ok
P3	DI14	DI13	3876	441	4317	0.10	0.87	0.09	0.09	6.0	0.00	4.01	0.3	15	69.3	0.012	0.0000	0.005	4.0	4.9	2.0	0.58	6.58	4.03	3.68	Q ok
EXP1	DI13	MH67	3876	441	4317	0.10	0.87	0.09	0.42	6.0	6.58	3.91	1.6	15	15	0.013	0.0006	***0.003***	***2.7***	3.3	2.6	0.09	6.68	-1.10	-1.14	Q ok
P2	DI2	DI1	3846	1139	4985	0.11	0.77	0.09	0.09	6.0	0.00	4.01	0.4	15	69.3	0.012	0.0000	0.005	4.0	4.9	2.0	0.58	6.58	4.03	3.68	Q ok
P1	DI1	EXMH	2301	1082	3383	0.08	0.70	0.05	0.14	6.0	6.58	3.91	0.6	15	3.34	0.012	0.0001	0.005	4.0	4.9	2.4	0.02	6.61	3.39	3.37	Q ok
CRB-P84	TD-04	EXMH	1667	0	1667	0.04	0.95	0.04	0.04	6.0	0.00	4.01	**0.15**	8	46	0.011	0.000104	0.0383	8.0	**2.8**	3.9	0.20	6.20	6.26	4.50	Q ok
EXP15	EXDI	EXMH	24757	6130	30887	0.71	0.80	0.57	0.57	6.0	0.00	4.01	**2.27**	12	87	0.012	0.003452	0.0049	3.5	**2.7**	3.9	0.37	6.37	2.00	1.57	Q ok
EXP16	EXMH	EXMH5	1	0	1	0.00	0.95	0.00	0.60	6.0	6.37	3.94	**2.37**	10	87	0.012	0.009998	0.0049	3.1	**1.7**	2.5	0.58	6.95	2.00	1.57	Undersized!
P42	DI31	MH22	12796.5	0	12797	0.29	0.95	0.28	0.28	6.0	0.00	4.01	1.1	15	55.8	0.012	0.0003	0.005	4.0	5.0	3.3	0.28	6.28	2.00	1.72	Q ok
P43	MH22	DI32	1	0	1	0.00	0.95	0.00	0.28	6.0	6.28	3.96	1.1	15	45.1	0.012	0.0002	0.005	4.1	5.0	3.1	0.25	6.53	1.62	1.39	Q ok
P44	DI32	EX	14459.5	0	14460	0.33	0.95	0.32	1.00	6.0	6.53	3.93	3.9	15	59.3	0.012	0.0031	0.030	9.9	12.1	8.4	0.12	6.64	1.29	0.70	Q ok
P46	DI34	DI33	2420	0	2420	0.06	0.95	0.05	0.05	6.0	0.00	4.01	0.2	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.0	0.32	6.32	2.00	1.82	Q ok
P45	DI33	DI32	15975	0	15975	0.37	0.95	0.35	0.40	6.0	6.32	3.96	1.6	15	48.5	0.012	0.0005	0.007	4.7	5.8	4.0	0.20	6.52	1.72	1.39	Q ok
EXP17	EXMH	EXMH8	1	0	1	0.00	0.95	0.00	0.00	6.0	0.00	4.01	0.0	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.0	0.32	6.32	2.00	1.82	Q ok
EX-P LOT	EXDI LOT	DI-MSS-41	13430	0	13430	0.31	0.95	0.29	0.29	6.0	0.00	4.01	**1.18**	12	47	0.012	0.000927	0.0074	4.2	**3.3**	3.8	0.21	6.21	2.50	2.15	Q ok
P48	DI40	DI41	3590	0	3590	0.08	0.95	0.08	0.08	6.0	0.00	4.01	0.3	12	82.1	0.012	0.0001	0.005	3.5	2.7	2.1	0.66	6.66	2.56	2.15	Q ok
P-MSS-48A	DI-MSS-41	EX-MH LOW	3072	0	3072	0.07	0.95	0.07	0.44	6.0	6.66	3.89	**1.71**	12	41	0.012	0.001955	0.0051	3.5	**2.8**	3.7	0.19	6.84	2.05	1.84	Q ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	7.11	7.11	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.11	7.41	
P5	MH1	MH2	1.20	7.11	7.11	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	7.11	7.93	HGL Too High!
P7	MH2	MH3	1.20	7.10	7.10	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	7.11	7.65	HGL Too High!
P10	MH3	MH4	1.20	7.09	7.09	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	7.10	7.28	HGL Too High!
P13	MH4	MH5	1.20	7.05	7.05	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	7.09	7.09	HGL Too High!
P15	MH5	MH20	1.60	6.99	6.99	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	7.05	7.40	HGL Too High!
P6	DI16	MH2	1.00	7.11	7.11	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.11	7.33	HGL Too High!
P9	DI3	MH3	1.00	7.10	7.10	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.11	6.62	HGL Too High!
P8	DI17	MH3	1.00	7.10	7.10	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.11	6.96	HGL Too High!
P12	DI4	MH4	1.00	7.09	7.09	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.10	6.48	HGL Too High!
P11	DI18	MH4	1.00	7.09	7.09	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.10	6.56	HGL Too High!
P14	DI5	MH5	1.00	7.05	7.05	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.05	6.61	HGL Too High!
P18	DI6	MH6	1.00	7.05	7.05	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.06	7.13	HGL Too High!
P16	MH6	MH5	1.20	7.05	7.05	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	7.05	7.55	HGL Too High!
P17	DI19	MH6	1.00	7.05	7.05	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.05	7.08	HGL Too High!
P32	DI23	MH12	1.00	7.63	7.63	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.64	4.24	HGL Too High!
P31	DI9	MH12	1.00	7.63	7.63	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.63	7.13	HGL Too High!
P30	MH12	MH11	1.60	7.63	7.63	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	7.63	7.48	HGL Too High!
P27	MH11	MH10	1.60	7.61	7.61	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	7.63	7.21	HGL Too High!
P25	MH10	MH9	1.60	7.60	7.60	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	7.61	7.54	HGL Too High!
P22	MH9	MH8	1.60	7.59	7.59	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	7.60	7.85	HGL Too High!
P20	MH8	MH21	1.60	7.57	7.57	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	7.59	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	7.55	7.55	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	7.57	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	7.55	7.55	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	7.57	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	7.59	7.59	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	7.60	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	7.64	7.64	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	7.72	4.78	HGL Too High!
P51	STUB	DI22	1.00	7.64	7.64	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.65	7.16	HGL Too High!
P28	DI22	MH11	1.00	7.63	7.63	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	7.64	6.74	HGL Too High!
P29	DI8	MH11	1.00	7.63	7.63	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.63	6.92	HGL Too High!
P26	DI21	MH10	1.00	7.61	7.61	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.61	7.23	HGL Too High!
P23	DI20	MH9	1.00	7.60	7.60	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	7.60	7.38	HGL Too High!
P24	DI7	MH9	1.00	7.60	7.60	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.60	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	18.22	18.22	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.22	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	18.22	18.22	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.22	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	18.17	18.17	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	18.22	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	18.12	18.12	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	18.17	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	17.87	17.87	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	18.12	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	17.71	17.71	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	17.87	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	14.43	14.43	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	17.71	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	12.07	12.07	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	14.43	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	8.05	8.05	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	12.07	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	7.55	7.55	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	8.05	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	6.99	6.99	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	7.55	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	6.77	6.77	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	6.99	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	5.04	5.04	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	6.77	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	3.81	3.81	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	5.04	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.20**	**3.20**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**3.81**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	18.75	18.75	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	21.17	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	18.75	18.75	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.76	6.45	HGL Too High!
P3	DI14	DI13	1.00	18.75	18.75	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.75	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	18.17	18.17	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	18.75	6.58	HGL Too High!
P2	DI2	DI1	1.00	18.12	18.12	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.12	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	18.12	18.12	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	18.12	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	18.68	18.68	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.69	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	18.68	18.68	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	19.01	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	17.71	17.71	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	18.68	8.13	HGL Too High!
P42	DI31	MH22	1.00	14.72	14.72	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.74	5.12	HGL Too High!
P43	MH22	DI32	1.00	14.70	14.70	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	14.72	5.45	HGL Too High!
P44	DI32	EX	1.00	14.43	14.43	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	14.70	5.23	HGL Too High!
P46	DI34	DI33	1.00	14.74	14.74	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.74	5.47	HGL Too High!
P45	DI33	DI32	1.00	14.70	14.70	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	14.74	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	8.05	8.05	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	8.05	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	17.83	17.83	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	17.88	3.63	HGL Too High!
P48	DI40	DI41	0.80	17.83	17.83	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.83	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	17.71	17.71	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	17.83	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	7.31	7.31	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.31	7.41	
P5	MH1	MH2	1.20	7.31	7.31	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	7.31	7.93	HGL Too High!
P7	MH2	MH3	1.20	7.30	7.30	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	7.31	7.65	HGL Too High!
P10	MH3	MH4	1.20	7.29	7.29	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	7.30	7.28	HGL Too High!
P13	MH4	MH5	1.20	7.25	7.25	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	7.29	7.09	HGL Too High!
P15	MH5	MH20	1.60	7.19	7.19	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	7.25	7.40	HGL Too High!
P6	DI16	MH2	1.00	7.31	7.31	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.31	7.33	HGL Too High!
P9	DI3	MH3	1.00	7.30	7.30	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.31	6.62	HGL Too High!
P8	DI17	MH3	1.00	7.30	7.30	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.31	6.96	HGL Too High!
P12	DI4	MH4	1.00	7.29	7.29	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.30	6.48	HGL Too High!
P11	DI18	MH4	1.00	7.29	7.29	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	7.30	6.56	HGL Too High!
P14	DI5	MH5	1.00	7.25	7.25	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.25	6.61	HGL Too High!
P18	DI6	MH6	1.00	7.25	7.25	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.26	7.13	HGL Too High!
P16	MH6	MH5	1.20	7.25	7.25	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	7.25	7.55	HGL Too High!
P17	DI19	MH6	1.00	7.25	7.25	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.25	7.08	HGL Too High!
P32	DI23	MH12	1.00	7.83	7.83	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.84	4.24	HGL Too High!
P31	DI9	MH12	1.00	7.83	7.83	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.83	7.13	HGL Too High!
P30	MH12	MH11	1.60	7.83	7.83	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	7.83	7.48	HGL Too High!
P27	MH11	MH10	1.60	7.81	7.81	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	7.83	7.21	HGL Too High!
P25	MH10	MH9	1.60	7.80	7.80	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	7.81	7.54	HGL Too High!
P22	MH9	MH8	1.60	7.79	7.79	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	7.80	7.85	HGL Too High!
P20	MH8	MH21	1.60	7.77	7.77	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	7.79	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	7.75	7.75	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	7.77	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	7.75	7.75	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	7.77	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	7.79	7.79	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	7.80	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	7.84	7.84	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	7.92	4.78	HGL Too High!
P51	STUB	DI22	1.00	7.84	7.84	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	7.85	7.16	HGL Too High!
P28	DI22	MH11	1.00	7.83	7.83	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	7.84	6.74	HGL Too High!
P29	DI8	MH11	1.00	7.83	7.83	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.83	6.92	HGL Too High!
P26	DI21	MH10	1.00	7.81	7.81	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.81	7.23	HGL Too High!
P23	DI20	MH9	1.00	7.80	7.80	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	7.80	7.38	HGL Too High!
P24	DI7	MH9	1.00	7.80	7.80	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	7.80	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	18.42	18.42	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.42	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	18.42	18.42	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.42	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	18.37	18.37	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	18.42	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	18.32	18.32	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	18.37	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	18.07	18.07	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	18.32	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	17.91	17.91	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	18.07	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	14.63	14.63	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	17.91	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	12.27	12.27	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	14.63	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	8.25	8.25	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	12.27	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	7.75	7.75	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	8.25	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	7.19	7.19	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	7.75	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	6.97	6.97	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	7.19	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	5.24	5.24	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	6.97	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	4.01	4.01	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	5.24	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.40**	**3.40**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**4.01**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	18.95	18.95	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	21.37	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	18.95	18.95	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.96	6.45	HGL Too High!
P3	DI14	DI13	1.00	18.95	18.95	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.95	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	18.37	18.37	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	18.95	6.58	HGL Too High!
P2	DI2	DI1	1.00	18.32	18.32	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.32	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	18.32	18.32	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	18.32	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	18.88	18.88	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.89	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	18.88	18.88	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	19.21	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	17.91	17.91	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	18.88	8.13	HGL Too High!
P42	DI31	MH22	1.00	14.92	14.92	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	14.94	5.12	HGL Too High!
P43	MH22	DI32	1.00	14.90	14.90	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	14.92	5.45	HGL Too High!
P44	DI32	EX	1.00	14.63	14.63	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	14.90	5.23	HGL Too High!
P46	DI34	DI33	1.00	14.94	14.94	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.94	5.47	HGL Too High!
P45	DI33	DI32	1.00	14.90	14.90	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	14.94	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	8.25	8.25	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	8.25	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	18.03	18.03	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	18.08	3.63	HGL Too High!
P48	DI40	DI41	0.80	18.03	18.03	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.03	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	17.91	17.91	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	18.03	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	10.81	10.81	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.81	7.41	
P5	MH1	MH2	1.20	10.81	10.81	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	10.81	7.93	HGL Too High!
P7	MH2	MH3	1.20	10.80	10.80	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	10.81	7.65	HGL Too High!
P10	MH3	MH4	1.20	10.79	10.79	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	10.80	7.28	HGL Too High!
P13	MH4	MH5	1.20	10.75	10.75	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	10.79	7.09	HGL Too High!
P15	MH5	MH20	1.60	10.69	10.69	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	10.75	7.40	HGL Too High!
P6	DI16	MH2	1.00	10.81	10.81	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.81	7.33	HGL Too High!
P9	DI3	MH3	1.00	10.80	10.80	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.81	6.62	HGL Too High!
P8	DI17	MH3	1.00	10.80	10.80	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.81	6.96	HGL Too High!
P12	DI4	MH4	1.00	10.79	10.79	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.80	6.48	HGL Too High!
P11	DI18	MH4	1.00	10.79	10.79	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	10.80	6.56	HGL Too High!
P14	DI5	MH5	1.00	10.75	10.75	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.75	6.61	HGL Too High!
P18	DI6	MH6	1.00	10.75	10.75	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.76	7.13	HGL Too High!
P16	MH6	MH5	1.20	10.75	10.75	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	10.75	7.55	HGL Too High!
P17	DI19	MH6	1.00	10.75	10.75	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.75	7.08	HGL Too High!
P32	DI23	MH12	1.00	11.33	11.33	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.34	4.24	HGL Too High!
P31	DI9	MH12	1.00	11.33	11.33	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.33	7.13	HGL Too High!
P30	MH12	MH11	1.60	11.33	11.33	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	11.33	7.48	HGL Too High!
P27	MH11	MH10	1.60	11.31	11.31	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	11.33	7.21	HGL Too High!
P25	MH10	MH9	1.60	11.30	11.30	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	11.31	7.54	HGL Too High!
P22	MH9	MH8	1.60	11.29	11.29	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	11.30	7.85	HGL Too High!
P20	MH8	MH21	1.60	11.27	11.27	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	11.29	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	11.25	11.25	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	11.27	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	11.25	11.25	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	11.27	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	11.29	11.29	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	11.30	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	11.34	11.34	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	11.42	4.78	HGL Too High!
P51	STUB	DI22	1.00	11.34	11.34	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.35	7.16	HGL Too High!
P28	DI22	MH11	1.00	11.33	11.33	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	11.34	6.74	HGL Too High!
P29	DI8	MH11	1.00	11.33	11.33	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.33	6.92	HGL Too High!
P26	DI21	MH10	1.00	11.31	11.31	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.31	7.23	HGL Too High!
P23	DI20	MH9	1.00	11.30	11.30	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	11.30	7.38	HGL Too High!
P24	DI7	MH9	1.00	11.30	11.30	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.30	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	21.92	21.92	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.92	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	21.92	21.92	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.92	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	21.87	21.87	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	21.92	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	21.82	21.82	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	21.87	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	21.57	21.57	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	21.82	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	21.41	21.41	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	21.57	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	18.13	18.13	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	21.41	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	15.77	15.77	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	18.13	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	11.75	11.75	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	15.77	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	11.25	11.25	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	11.75	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	10.69	10.69	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	11.25	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	10.47	10.47	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	10.69	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	8.74	8.74	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	10.47	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	7.51	7.51	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	8.74	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**6.90**	**6.90**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**7.51**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	22.45	22.45	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	24.87	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	22.45	22.45	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.46	6.45	HGL Too High!
P3	DI14	DI13	1.00	22.45	22.45	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.45	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	21.87	21.87	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	22.45	6.58	HGL Too High!
P2	DI2	DI1	1.00	21.82	21.82	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.82	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	21.82	21.82	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	21.82	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	22.38	22.38	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.39	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	22.38	22.38	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	22.71	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	21.41	21.41	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	22.38	8.13	HGL Too High!
P42	DI31	MH22	1.00	18.42	18.42	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	18.44	5.12	HGL Too High!
P43	MH22	DI32	1.00	18.40	18.40	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	18.42	5.45	HGL Too High!
P44	DI32	EX	1.00	18.13	18.13	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	18.40	5.23	HGL Too High!
P46	DI34	DI33	1.00	18.44	18.44	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.44	5.47	HGL Too High!
P45	DI33	DI32	1.00	18.40	18.40	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	18.44	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	11.75	11.75	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	11.75	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	21.53	21.53	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	21.58	3.63	HGL Too High!
P48	DI40	DI41	0.80	21.53	21.53	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.53	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	21.41	21.41	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	21.53	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	11.31	11.31	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.31	7.41	
P5	MH1	MH2	1.20	11.31	11.31	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	11.31	7.93	HGL Too High!
P7	MH2	MH3	1.20	11.30	11.30	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	11.31	7.65	HGL Too High!
P10	MH3	MH4	1.20	11.29	11.29	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	11.30	7.28	HGL Too High!
P13	MH4	MH5	1.20	11.25	11.25	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	11.29	7.09	HGL Too High!
P15	MH5	MH20	1.60	11.19	11.19	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	11.25	7.40	HGL Too High!
P6	DI16	MH2	1.00	11.31	11.31	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.31	7.33	HGL Too High!
P9	DI3	MH3	1.00	11.30	11.30	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.31	6.62	HGL Too High!
P8	DI17	MH3	1.00	11.30	11.30	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.31	6.96	HGL Too High!
P12	DI4	MH4	1.00	11.29	11.29	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.30	6.48	HGL Too High!
P11	DI18	MH4	1.00	11.29	11.29	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.30	6.56	HGL Too High!
P14	DI5	MH5	1.00	11.25	11.25	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.25	6.61	HGL Too High!
P18	DI6	MH6	1.00	11.25	11.25	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.26	7.13	HGL Too High!
P16	MH6	MH5	1.20	11.25	11.25	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	11.25	7.55	HGL Too High!
P17	DI19	MH6	1.00	11.25	11.25	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.25	7.08	HGL Too High!
P32	DI23	MH12	1.00	11.83	11.83	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.84	4.24	HGL Too High!
P31	DI9	MH12	1.00	11.83	11.83	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.83	7.13	HGL Too High!
P30	MH12	MH11	1.60	11.83	11.83	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	11.83	7.48	HGL Too High!
P27	MH11	MH10	1.60	11.81	11.81	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	11.83	7.21	HGL Too High!
P25	MH10	MH9	1.60	11.80	11.80	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	11.81	7.54	HGL Too High!
P22	MH9	MH8	1.60	11.79	11.79	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	11.80	7.85	HGL Too High!
P20	MH8	MH21	1.60	11.77	11.77	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	11.79	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	11.75	11.75	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	11.77	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	11.75	11.75	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	11.77	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	11.79	11.79	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	11.80	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	11.84	11.84	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	11.92	4.78	HGL Too High!
P51	STUB	DI22	1.00	11.84	11.84	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	11.85	7.16	HGL Too High!
P28	DI22	MH11	1.00	11.83	11.83	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	11.84	6.74	HGL Too High!
P29	DI8	MH11	1.00	11.83	11.83	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.83	6.92	HGL Too High!
P26	DI21	MH10	1.00	11.81	11.81	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.81	7.23	HGL Too High!
P23	DI20	MH9	1.00	11.80	11.80	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	11.80	7.38	HGL Too High!
P24	DI7	MH9	1.00	11.80	11.80	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.80	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	22.42	22.42	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.42	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	22.42	22.42	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.42	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	22.37	22.37	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	22.42	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	22.32	22.32	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	22.37	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	22.07	22.07	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	22.32	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	21.91	21.91	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	22.07	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	18.63	18.63	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	21.91	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	16.27	16.27	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	18.63	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	12.25	12.25	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	16.27	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	11.75	11.75	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	12.25	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	11.19	11.19	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	11.75	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	10.97	10.97	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	11.19	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	9.24	9.24	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	10.97	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	8.01	8.01	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	9.24	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.40**	**7.40**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**8.01**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	22.95	22.95	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	25.37	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	22.95	22.95	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.96	6.45	HGL Too High!
P3	DI14	DI13	1.00	22.95	22.95	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.95	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	22.37	22.37	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	22.95	6.58	HGL Too High!
P2	DI2	DI1	1.00	22.32	22.32	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.32	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	22.32	22.32	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	22.32	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	22.88	22.88	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.89	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	22.88	22.88	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	23.21	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	21.91	21.91	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	22.88	8.13	HGL Too High!
P42	DI31	MH22	1.00	18.92	18.92	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	18.94	5.12	HGL Too High!
P43	MH22	DI32	1.00	18.90	18.90	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	18.92	5.45	HGL Too High!
P44	DI32	EX	1.00	18.63	18.63	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	18.90	5.23	HGL Too High!
P46	DI34	DI33	1.00	18.94	18.94	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.94	5.47	HGL Too High!
P45	DI33	DI32	1.00	18.90	18.90	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	18.94	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	12.25	12.25	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	12.25	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	22.03	22.03	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	22.08	3.63	HGL Too High!
P48	DI40	DI41	0.80	22.03	22.03	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.03	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	21.91	21.91	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	22.03	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	11.71	11.71	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.71	7.41	
P5	MH1	MH2	1.20	11.71	11.71	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	11.71	7.93	HGL Too High!
P7	MH2	MH3	1.20	11.70	11.70	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	11.71	7.65	HGL Too High!
P10	MH3	MH4	1.20	11.69	11.69	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	11.70	7.28	HGL Too High!
P13	MH4	MH5	1.20	11.65	11.65	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	11.69	7.09	HGL Too High!
P15	MH5	MH20	1.60	11.59	11.59	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	11.65	7.40	HGL Too High!
P6	DI16	MH2	1.00	11.71	11.71	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.71	7.33	HGL Too High!
P9	DI3	MH3	1.00	11.70	11.70	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.71	6.62	HGL Too High!
P8	DI17	MH3	1.00	11.70	11.70	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.71	6.96	HGL Too High!
P12	DI4	MH4	1.00	11.69	11.69	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.70	6.48	HGL Too High!
P11	DI18	MH4	1.00	11.69	11.69	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.70	6.56	HGL Too High!
P14	DI5	MH5	1.00	11.65	11.65	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.65	6.61	HGL Too High!
P18	DI6	MH6	1.00	11.65	11.65	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.66	7.13	HGL Too High!
P16	MH6	MH5	1.20	11.65	11.65	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	11.65	7.55	HGL Too High!
P17	DI19	MH6	1.00	11.65	11.65	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.65	7.08	HGL Too High!
P32	DI23	MH12	1.00	12.23	12.23	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.24	4.24	HGL Too High!
P31	DI9	MH12	1.00	12.23	12.23	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.23	7.13	HGL Too High!
P30	MH12	MH11	1.60	12.23	12.23	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	12.23	7.48	HGL Too High!
P27	MH11	MH10	1.60	12.21	12.21	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	12.23	7.21	HGL Too High!
P25	MH10	MH9	1.60	12.20	12.20	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	12.21	7.54	HGL Too High!
P22	MH9	MH8	1.60	12.19	12.19	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	12.20	7.85	HGL Too High!
P20	MH8	MH21	1.60	12.17	12.17	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	12.19	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	12.15	12.15	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	12.17	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	12.15	12.15	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	12.17	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	12.19	12.19	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	12.20	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	12.24	12.24	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	12.32	4.78	HGL Too High!
P51	STUB	DI22	1.00	12.24	12.24	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	12.25	7.16	HGL Too High!
P28	DI22	MH11	1.00	12.23	12.23	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.24	6.74	HGL Too High!
P29	DI8	MH11	1.00	12.23	12.23	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.23	6.92	HGL Too High!
P26	DI21	MH10	1.00	12.21	12.21	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.21	7.23	HGL Too High!
P23	DI20	MH9	1.00	12.20	12.20	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	12.20	7.38	HGL Too High!
P24	DI7	MH9	1.00	12.20	12.20	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.20	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	22.82	22.82	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.82	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	22.82	22.82	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.82	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	22.77	22.77	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	22.82	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	22.72	22.72	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	22.77	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	22.47	22.47	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	22.72	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	22.31	22.31	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	22.47	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	19.03	19.03	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	22.31	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	16.67	16.67	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	19.03	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	12.65	12.65	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	16.67	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	12.15	12.15	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	12.65	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	11.59	11.59	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	12.15	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	11.37	11.37	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	11.59	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	9.64	9.64	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	11.37	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	8.41	8.41	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	9.64	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.80**	**7.80**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**8.41**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	23.35	23.35	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	25.77	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	23.35	23.35	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.36	6.45	HGL Too High!
P3	DI14	DI13	1.00	23.35	23.35	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.35	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	22.77	22.77	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	23.35	6.58	HGL Too High!
P2	DI2	DI1	1.00	22.72	22.72	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.72	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	22.72	22.72	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	22.72	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	23.28	23.28	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.29	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	23.28	23.28	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	23.61	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	22.31	22.31	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	23.28	8.13	HGL Too High!
P42	DI31	MH22	1.00	19.32	19.32	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	19.34	5.12	HGL Too High!
P43	MH22	DI32	1.00	19.30	19.30	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	19.32	5.45	HGL Too High!
P44	DI32	EX	1.00	19.03	19.03	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	19.30	5.23	HGL Too High!
P46	DI34	DI33	1.00	19.34	19.34	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.34	5.47	HGL Too High!
P45	DI33	DI32	1.00	19.30	19.30	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	19.34	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	12.65	12.65	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	12.65	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	22.43	22.43	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	22.48	3.63	HGL Too High!
P48	DI40	DI41	0.80	22.43	22.43	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.43	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	22.31	22.31	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	22.43	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	12.21	12.21	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.21	7.41	
P5	MH1	MH2	1.20	12.21	12.21	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	12.21	7.93	HGL Too High!
P7	MH2	MH3	1.20	12.20	12.20	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	12.21	7.65	HGL Too High!
P10	MH3	MH4	1.20	12.19	12.19	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	12.20	7.28	HGL Too High!
P13	MH4	MH5	1.20	12.15	12.15	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	12.19	7.09	HGL Too High!
P15	MH5	MH20	1.60	12.09	12.09	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	12.15	7.40	HGL Too High!
P6	DI16	MH2	1.00	12.21	12.21	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.21	7.33	HGL Too High!
P9	DI3	MH3	1.00	12.20	12.20	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.21	6.62	HGL Too High!
P8	DI17	MH3	1.00	12.20	12.20	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.21	6.96	HGL Too High!
P12	DI4	MH4	1.00	12.19	12.19	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.20	6.48	HGL Too High!
P11	DI18	MH4	1.00	12.19	12.19	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.20	6.56	HGL Too High!
P14	DI5	MH5	1.00	12.15	12.15	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.15	6.61	HGL Too High!
P18	DI6	MH6	1.00	12.15	12.15	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.16	7.13	HGL Too High!
P16	MH6	MH5	1.20	12.15	12.15	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	12.15	7.55	HGL Too High!
P17	DI19	MH6	1.00	12.15	12.15	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.15	7.08	HGL Too High!
P32	DI23	MH12	1.00	12.73	12.73	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.74	4.24	HGL Too High!
P31	DI9	MH12	1.00	12.73	12.73	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.73	7.13	HGL Too High!
P30	MH12	MH11	1.60	12.73	12.73	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	12.73	7.48	HGL Too High!
P27	MH11	MH10	1.60	12.71	12.71	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	12.73	7.21	HGL Too High!
P25	MH10	MH9	1.60	12.70	12.70	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	12.71	7.54	HGL Too High!
P22	MH9	MH8	1.60	12.69	12.69	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	12.70	7.85	HGL Too High!
P20	MH8	MH21	1.60	12.67	12.67	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	12.69	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	12.65	12.65	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	12.67	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	12.65	12.65	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	12.67	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	12.69	12.69	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	12.70	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	12.74	12.74	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	12.82	4.78	HGL Too High!
P51	STUB	DI22	1.00	12.74	12.74	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	12.75	7.16	HGL Too High!
P28	DI22	MH11	1.00	12.73	12.73	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	12.74	6.74	HGL Too High!
P29	DI8	MH11	1.00	12.73	12.73	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.73	6.92	HGL Too High!
P26	DI21	MH10	1.00	12.71	12.71	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.71	7.23	HGL Too High!
P23	DI20	MH9	1.00	12.70	12.70	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	12.70	7.38	HGL Too High!
P24	DI7	MH9	1.00	12.70	12.70	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.70	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	23.32	23.32	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.32	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	23.32	23.32	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.32	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	23.27	23.27	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	23.32	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	23.22	23.22	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	23.27	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	22.97	22.97	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	23.22	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	22.81	22.81	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	22.97	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	19.53	19.53	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	22.81	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	17.17	17.17	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	19.53	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	13.15	13.15	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	17.17	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	12.65	12.65	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	13.15	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	12.09	12.09	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	12.65	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	11.87	11.87	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	12.09	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	10.14	10.14	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	11.87	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	8.91	8.91	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	10.14	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**8.30**	**8.30**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**8.91**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	23.85	23.85	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	26.27	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	23.85	23.85	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.86	6.45	HGL Too High!
P3	DI14	DI13	1.00	23.85	23.85	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.85	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	23.27	23.27	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	23.85	6.58	HGL Too High!
P2	DI2	DI1	1.00	23.22	23.22	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.22	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	23.22	23.22	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	23.22	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	23.78	23.78	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.79	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	23.78	23.78	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	24.11	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	22.81	22.81	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	23.78	8.13	HGL Too High!
P42	DI31	MH22	1.00	19.82	19.82	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	19.84	5.12	HGL Too High!
P43	MH22	DI32	1.00	19.80	19.80	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	19.82	5.45	HGL Too High!
P44	DI32	EX	1.00	19.53	19.53	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	19.80	5.23	HGL Too High!
P46	DI34	DI33	1.00	19.84	19.84	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.84	5.47	HGL Too High!
P45	DI33	DI32	1.00	19.80	19.80	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	19.84	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	13.15	13.15	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	13.15	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	22.93	22.93	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	22.98	3.63	HGL Too High!
P48	DI40	DI41	0.80	22.93	22.93	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.93	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	22.81	22.81	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	22.93	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	12.91	12.91	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.91	7.41	
P5	MH1	MH2	1.20	12.91	12.91	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	12.91	7.93	HGL Too High!
P7	MH2	MH3	1.20	12.90	12.90	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	12.91	7.65	HGL Too High!
P10	MH3	MH4	1.20	12.89	12.89	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	12.90	7.28	HGL Too High!
P13	MH4	MH5	1.20	12.85	12.85	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	12.89	7.09	HGL Too High!
P15	MH5	MH20	1.60	12.79	12.79	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	12.85	7.40	HGL Too High!
P6	DI16	MH2	1.00	12.91	12.91	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.91	7.33	HGL Too High!
P9	DI3	MH3	1.00	12.90	12.90	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.91	6.62	HGL Too High!
P8	DI17	MH3	1.00	12.90	12.90	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.91	6.96	HGL Too High!
P12	DI4	MH4	1.00	12.89	12.89	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.90	6.48	HGL Too High!
P11	DI18	MH4	1.00	12.89	12.89	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.90	6.56	HGL Too High!
P14	DI5	MH5	1.00	12.85	12.85	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.85	6.61	HGL Too High!
P18	DI6	MH6	1.00	12.85	12.85	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.86	7.13	HGL Too High!
P16	MH6	MH5	1.20	12.85	12.85	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	12.85	7.55	HGL Too High!
P17	DI19	MH6	1.00	12.85	12.85	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.85	7.08	HGL Too High!
P32	DI23	MH12	1.00	13.43	13.43	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.44	4.24	HGL Too High!
P31	DI9	MH12	1.00	13.43	13.43	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.43	7.13	HGL Too High!
P30	MH12	MH11	1.60	13.43	13.43	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	13.43	7.48	HGL Too High!
P27	MH11	MH10	1.60	13.41	13.41	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	13.43	7.21	HGL Too High!
P25	MH10	MH9	1.60	13.40	13.40	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	13.41	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.39	13.39	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	13.40	7.85	HGL Too High!
P20	MH8	MH21	1.60	13.37	13.37	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	13.39	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	13.35	13.35	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	13.37	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	13.35	13.35	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	13.37	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	13.39	13.39	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	13.40	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	13.44	13.44	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	13.52	4.78	HGL Too High!
P51	STUB	DI22	1.00	13.44	13.44	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	13.45	7.16	HGL Too High!
P28	DI22	MH11	1.00	13.43	13.43	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	13.44	6.74	HGL Too High!
P29	DI8	MH11	1.00	13.43	13.43	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.43	6.92	HGL Too High!
P26	DI21	MH10	1.00	13.41	13.41	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.41	7.23	HGL Too High!
P23	DI20	MH9	1.00	13.40	13.40	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	13.40	7.38	HGL Too High!
P24	DI7	MH9	1.00	13.40	13.40	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.40	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	24.02	24.02	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.02	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	24.02	24.02	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.02	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	23.97	23.97	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	24.02	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	23.92	23.92	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	23.97	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	23.67	23.67	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	23.92	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	23.51	23.51	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	23.67	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	20.23	20.23	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	23.51	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	17.87	17.87	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	20.23	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	13.85	13.85	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	17.87	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	13.35	13.35	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	13.85	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	12.79	12.79	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	13.35	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	12.57	12.57	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	12.79	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	10.84	10.84	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	12.57	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.61	9.61	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	10.84	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.00**	**9.00**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**9.61**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	24.55	24.55	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	26.97	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	24.55	24.55	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.56	6.45	HGL Too High!
P3	DI14	DI13	1.00	24.55	24.55	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.55	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	23.97	23.97	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	24.55	6.58	HGL Too High!
P2	DI2	DI1	1.00	23.92	23.92	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.92	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	23.92	23.92	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	23.92	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	24.48	24.48	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.49	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	24.48	24.48	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	24.81	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	23.51	23.51	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	24.48	8.13	HGL Too High!
P42	DI31	MH22	1.00	20.52	20.52	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	20.54	5.12	HGL Too High!
P43	MH22	DI32	1.00	20.50	20.50	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	20.52	5.45	HGL Too High!
P44	DI32	EX	1.00	20.23	20.23	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	20.50	5.23	HGL Too High!
P46	DI34	DI33	1.00	20.54	20.54	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.54	5.47	HGL Too High!
P45	DI33	DI32	1.00	20.50	20.50	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	20.54	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	13.85	13.85	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	13.85	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	23.63	23.63	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	23.68	3.63	HGL Too High!
P48	DI40	DI41	0.80	23.63	23.63	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.63	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	23.51	23.51	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	23.63	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	13.41	13.41	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.41	7.41	
P5	MH1	MH2	1.20	13.41	13.41	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	13.41	7.93	HGL Too High!
P7	MH2	MH3	1.20	13.40	13.40	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	13.41	7.65	HGL Too High!
P10	MH3	MH4	1.20	13.39	13.39	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	13.40	7.28	HGL Too High!
P13	MH4	MH5	1.20	13.35	13.35	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	13.39	7.09	HGL Too High!
P15	MH5	MH20	1.60	13.29	13.29	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	13.35	7.40	HGL Too High!
P6	DI16	MH2	1.00	13.41	13.41	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.41	7.33	HGL Too High!
P9	DI3	MH3	1.00	13.40	13.40	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.41	6.62	HGL Too High!
P8	DI17	MH3	1.00	13.40	13.40	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.41	6.96	HGL Too High!
P12	DI4	MH4	1.00	13.39	13.39	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.40	6.48	HGL Too High!
P11	DI18	MH4	1.00	13.39	13.39	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.40	6.56	HGL Too High!
P14	DI5	MH5	1.00	13.35	13.35	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.35	6.61	HGL Too High!
P18	DI6	MH6	1.00	13.35	13.35	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.36	7.13	HGL Too High!
P16	MH6	MH5	1.20	13.35	13.35	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	13.35	7.55	HGL Too High!
P17	DI19	MH6	1.00	13.35	13.35	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.35	7.08	HGL Too High!
P32	DI23	MH12	1.00	13.93	13.93	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.94	4.24	HGL Too High!
P31	DI9	MH12	1.00	13.93	13.93	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.93	7.13	HGL Too High!
P30	MH12	MH11	1.60	13.93	13.93	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	13.93	7.48	HGL Too High!
P27	MH11	MH10	1.60	13.91	13.91	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	13.93	7.21	HGL Too High!
P25	MH10	MH9	1.60	13.90	13.90	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	13.91	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.89	13.89	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	13.90	7.85	HGL Too High!
P20	MH8	MH21	1.60	13.87	13.87	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	13.89	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	13.85	13.85	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	13.87	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	13.85	13.85	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	13.87	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	13.89	13.89	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	13.90	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	13.94	13.94	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	14.02	4.78	HGL Too High!
P51	STUB	DI22	1.00	13.94	13.94	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	13.95	7.16	HGL Too High!
P28	DI22	MH11	1.00	13.93	13.93	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	13.94	6.74	HGL Too High!
P29	DI8	MH11	1.00	13.93	13.93	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.93	6.92	HGL Too High!
P26	DI21	MH10	1.00	13.91	13.91	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.91	7.23	HGL Too High!
P23	DI20	MH9	1.00	13.90	13.90	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	13.90	7.38	HGL Too High!
P24	DI7	MH9	1.00	13.90	13.90	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.90	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	24.52	24.52	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.52	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	24.52	24.52	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.52	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	24.47	24.47	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	24.52	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	24.42	24.42	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	24.47	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	24.17	24.17	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	24.42	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	24.01	24.01	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	24.17	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	20.73	20.73	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	24.01	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	18.37	18.37	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	20.73	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	14.35	14.35	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	18.37	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	13.85	13.85	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	14.35	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	13.29	13.29	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	13.85	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	13.07	13.07	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	13.29	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	11.34	11.34	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	13.07	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.11	10.11	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	11.34	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.50**	**9.50**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**10.11**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	25.05	25.05	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	27.47	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	25.05	25.05	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.06	6.45	HGL Too High!
P3	DI14	DI13	1.00	25.05	25.05	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.05	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	24.47	24.47	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	25.05	6.58	HGL Too High!
P2	DI2	DI1	1.00	24.42	24.42	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.42	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	24.42	24.42	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	24.42	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	24.98	24.98	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.99	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	24.98	24.98	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	25.31	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	24.01	24.01	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	24.98	8.13	HGL Too High!
P42	DI31	MH22	1.00	21.02	21.02	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	21.04	5.12	HGL Too High!
P43	MH22	DI32	1.00	21.00	21.00	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	21.02	5.45	HGL Too High!
P44	DI32	EX	1.00	20.73	20.73	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	21.00	5.23	HGL Too High!
P46	DI34	DI33	1.00	21.04	21.04	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.04	5.47	HGL Too High!
P45	DI33	DI32	1.00	21.00	21.00	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	21.04	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	14.35	14.35	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.35	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	24.13	24.13	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	24.18	3.63	HGL Too High!
P48	DI40	DI41	0.80	24.13	24.13	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.13	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	24.01	24.01	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	24.13	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	14.71	14.71	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.71	7.41	
P5	MH1	MH2	1.20	14.71	14.71	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	14.71	7.93	HGL Too High!
P7	MH2	MH3	1.20	14.70	14.70	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	14.71	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.69	14.69	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	14.70	7.28	HGL Too High!
P13	MH4	MH5	1.20	14.65	14.65	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	14.69	7.09	HGL Too High!
P15	MH5	MH20	1.60	14.59	14.59	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	14.65	7.40	HGL Too High!
P6	DI16	MH2	1.00	14.71	14.71	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.71	7.33	HGL Too High!
P9	DI3	MH3	1.00	14.70	14.70	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.71	6.62	HGL Too High!
P8	DI17	MH3	1.00	14.70	14.70	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.71	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.69	14.69	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.70	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.69	14.69	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.70	6.56	HGL Too High!
P14	DI5	MH5	1.00	14.65	14.65	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.65	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.65	14.65	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.66	7.13	HGL Too High!
P16	MH6	MH5	1.20	14.65	14.65	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	14.65	7.55	HGL Too High!
P17	DI19	MH6	1.00	14.65	14.65	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.65	7.08	HGL Too High!
P32	DI23	MH12	1.00	15.23	15.23	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.24	4.24	HGL Too High!
P31	DI9	MH12	1.00	15.23	15.23	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.23	7.13	HGL Too High!
P30	MH12	MH11	1.60	15.23	15.23	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	15.23	7.48	HGL Too High!
P27	MH11	MH10	1.60	15.21	15.21	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	15.23	7.21	HGL Too High!
P25	MH10	MH9	1.60	15.20	15.20	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	15.21	7.54	HGL Too High!
P22	MH9	MH8	1.60	15.19	15.19	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	15.20	7.85	HGL Too High!
P20	MH8	MH21	1.60	15.17	15.17	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	15.19	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	15.15	15.15	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	15.17	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	15.15	15.15	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	15.17	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	15.19	15.19	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	15.20	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	15.24	15.24	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	15.32	4.78	HGL Too High!
P51	STUB	DI22	1.00	15.24	15.24	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	15.25	7.16	HGL Too High!
P28	DI22	MH11	1.00	15.23	15.23	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	15.24	6.74	HGL Too High!
P29	DI8	MH11	1.00	15.23	15.23	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.23	6.92	HGL Too High!
P26	DI21	MH10	1.00	15.21	15.21	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.21	7.23	HGL Too High!
P23	DI20	MH9	1.00	15.20	15.20	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	15.20	7.38	HGL Too High!
P24	DI7	MH9	1.00	15.20	15.20	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.20	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	25.82	25.82	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.82	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	25.82	25.82	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.82	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	25.77	25.77	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	25.82	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	25.72	25.72	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	25.77	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	25.47	25.47	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	25.72	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	25.31	25.31	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	25.47	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	22.03	22.03	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	25.31	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	19.67	19.67	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	22.03	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	15.65	15.65	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	19.67	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	15.15	15.15	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	15.65	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	14.59	14.59	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	15.15	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	14.37	14.37	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	14.59	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.64	12.64	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	14.37	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.41	11.41	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	12.64	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.80**	**10.80**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**11.41**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	26.35	26.35	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	28.77	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	26.35	26.35	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.36	6.45	HGL Too High!
P3	DI14	DI13	1.00	26.35	26.35	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.35	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	25.77	25.77	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	26.35	6.58	HGL Too High!
P2	DI2	DI1	1.00	25.72	25.72	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.72	6.84	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	25.72	25.72	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	25.72	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	26.28	26.28	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.29	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	26.28	26.28	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	26.61	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	25.31	25.31	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	26.28	8.13	HGL Too High!
P42	DI31	MH22	1.00	22.32	22.32	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	22.34	5.12	HGL Too High!
P43	MH22	DI32	1.00	22.30	22.30	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	22.32	5.45	HGL Too High!
P44	DI32	EX	1.00	22.03	22.03	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	22.30	5.23	HGL Too High!
P46	DI34	DI33	1.00	22.34	22.34	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.34	5.47	HGL Too High!
P45	DI33	DI32	1.00	22.30	22.30	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	22.34	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	15.65	15.65	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	15.65	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	25.43	25.43	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	25.48	3.63	HGL Too High!
P48	DI40	DI41	0.80	25.43	25.43	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.43	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	25.31	25.31	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	25.43	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	9.65	9.65	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.65	7.41	
P5	MH1	MH2	1.20	9.65	9.65	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	9.65	7.93	HGL Too High!
P7	MH2	MH3	1.20	9.64	9.64	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	9.65	7.65	HGL Too High!
P10	MH3	MH4	1.20	9.63	9.63	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	9.64	7.28	HGL Too High!
P13	MH4	MH5	1.20	9.59	9.59	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	9.63	7.09	HGL Too High!
P15	MH5	MH20	1.60	9.53	9.53	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	9.59	7.40	HGL Too High!
P6	DI16	MH2	1.00	9.65	9.65	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.65	7.33	HGL Too High!
P9	DI3	MH3	1.00	9.64	9.64	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.65	6.62	HGL Too High!
P8	DI17	MH3	1.00	9.64	9.64	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.65	6.96	HGL Too High!
P12	DI4	MH4	1.00	9.63	9.63	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.64	6.48	HGL Too High!
P11	DI18	MH4	1.00	9.63	9.63	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.64	6.56	HGL Too High!
P14	DI5	MH5	1.00	9.59	9.59	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.59	6.61	HGL Too High!
P18	DI6	MH6	1.00	9.59	9.59	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.60	7.13	HGL Too High!
P16	MH6	MH5	1.20	9.59	9.59	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	9.59	7.55	HGL Too High!
P17	DI19	MH6	1.00	9.59	9.59	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.59	7.08	HGL Too High!
P32	DI23	MH12	1.00	10.17	10.17	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.18	4.24	HGL Too High!
P31	DI9	MH12	1.00	10.17	10.17	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.17	7.13	HGL Too High!
P30	MH12	MH11	1.60	10.17	10.17	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	10.17	7.48	HGL Too High!
P27	MH11	MH10	1.60	10.15	10.15	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	10.17	7.21	HGL Too High!
P25	MH10	MH9	1.60	10.14	10.14	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	10.15	7.54	HGL Too High!
P22	MH9	MH8	1.60	10.13	10.13	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	10.14	7.85	HGL Too High!
P20	MH8	MH21	1.60	10.11	10.11	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	10.13	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	10.09	10.09	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	10.11	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	10.09	10.09	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	10.11	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	10.13	10.13	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	10.14	7.34	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	10.18	10.18	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	10.26	4.78	HGL Too High!
P51	STUB	DI22	1.00	10.18	10.18	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.19	7.16	HGL Too High!
P28	DI22	MH11	1.00	10.17	10.17	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	10.18	6.74	HGL Too High!
P29	DI8	MH11	1.00	10.17	10.17	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.17	6.92	HGL Too High!
P26	DI21	MH10	1.00	10.15	10.15	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.15	7.23	HGL Too High!
P23	DI20	MH9	1.00	10.14	10.14	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	10.14	7.38	HGL Too High!
P24	DI7	MH9	1.00	10.14	10.14	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.14	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	20.76	20.76	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.76	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	20.76	20.76	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.76	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	20.71	20.71	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	20.76	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	20.66	20.66	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	20.71	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	20.41	20.41	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	20.66	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	20.25	20.25	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	20.41	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	16.97	16.97	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	20.25	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	14.61	14.61	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	16.97	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	10.59	10.59	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	14.61	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	10.09	10.09	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	10.59	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	9.53	9.53	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	10.09	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	9.31	9.31	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	9.53	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	7.58	7.58	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	9.31	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	6.35	6.35	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	7.58	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.74**	**5.74**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**6.35**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	21.29	21.29	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	23.71	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	21.29	21.29	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.30	6.45	HGL Too High!
P3	DI14	DI13	1.00	21.29	21.29	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.29	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	20.71	20.71	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	21.29	6.58	HGL Too High!
P2	DI2	DI1	1.00	20.66	20.66	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.66	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	20.66	20.66	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	20.66	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	21.22	21.22	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.23	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	21.22	21.22	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	21.55	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	20.25	20.25	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	21.22	8.13	HGL Too High!
P42	DI31	MH22	1.00	17.26	17.26	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	17.28	5.12	HGL Too High!
P43	MH22	DI32	1.00	17.24	17.24	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	17.26	5.45	HGL Too High!
P44	DI32	EX	1.00	16.97	16.97	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	17.24	5.23	HGL Too High!
P46	DI34	DI33	1.00	17.28	17.28	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.28	5.47	HGL Too High!
P45	DI33	DI32	1.00	17.24	17.24	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	17.28	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	10.59	10.59	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	10.59	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	20.37	20.37	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	20.42	3.63	HGL Too High!
P48	DI40	DI41	0.80	20.37	20.37	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.37	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	20.25	20.25	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	20.37	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	9.85	9.85	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.85	7.41	
P5	MH1	MH2	1.20	9.85	9.85	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	9.85	7.93	HGL Too High!
P7	MH2	MH3	1.20	9.84	9.84	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	9.85	7.65	HGL Too High!
P10	MH3	MH4	1.20	9.83	9.83	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	9.84	7.28	HGL Too High!
P13	MH4	MH5	1.20	9.79	9.79	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	9.83	7.09	HGL Too High!
P15	MH5	MH20	1.60	9.73	9.73	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	9.79	7.40	HGL Too High!
P6	DI16	MH2	1.00	9.85	9.85	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.85	7.33	HGL Too High!
P9	DI3	MH3	1.00	9.84	9.84	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.85	6.62	HGL Too High!
P8	DI17	MH3	1.00	9.84	9.84	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.85	6.96	HGL Too High!
P12	DI4	MH4	1.00	9.83	9.83	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.84	6.48	HGL Too High!
P11	DI18	MH4	1.00	9.83	9.83	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	9.84	6.56	HGL Too High!
P14	DI5	MH5	1.00	9.79	9.79	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.79	6.61	HGL Too High!
P18	DI6	MH6	1.00	9.79	9.79	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.80	7.13	HGL Too High!
P16	MH6	MH5	1.20	9.79	9.79	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	9.79	7.55	HGL Too High!
P17	DI19	MH6	1.00	9.79	9.79	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.79	7.08	HGL Too High!
P32	DI23	MH12	1.00	10.37	10.37	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.38	4.24	HGL Too High!
P31	DI9	MH12	1.00	10.37	10.37	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.37	7.13	HGL Too High!
P30	MH12	MH11	1.60	10.37	10.37	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	10.37	7.48	HGL Too High!
P27	MH11	MH10	1.60	10.35	10.35	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	10.37	7.21	HGL Too High!
P25	MH10	MH9	1.60	10.34	10.34	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	10.35	7.54	HGL Too High!
P22	MH9	MH8	1.60	10.33	10.33	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	10.34	7.85	HGL Too High!
P20	MH8	MH21	1.60	10.31	10.31	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	10.33	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	10.29	10.29	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	10.31	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	10.29	10.29	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	10.31	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	10.33	10.33	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	10.34	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	10.38	10.38	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	10.46	4.78	HGL Too High!
P51	STUB	DI22	1.00	10.38	10.38	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	10.39	7.16	HGL Too High!
P28	DI22	MH11	1.00	10.37	10.37	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	10.38	6.74	HGL Too High!
P29	DI8	MH11	1.00	10.37	10.37	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.37	6.92	HGL Too High!
P26	DI21	MH10	1.00	10.35	10.35	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.35	7.23	HGL Too High!
P23	DI20	MH9	1.00	10.34	10.34	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	10.34	7.38	HGL Too High!
P24	DI7	MH9	1.00	10.34	10.34	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	10.34	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	20.96	20.96	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.96	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	20.96	20.96	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.96	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	20.91	20.91	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	20.96	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	20.86	20.86	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	20.91	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	20.61	20.61	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	20.86	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	20.45	20.45	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	20.61	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	17.17	17.17	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	20.45	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	14.81	14.81	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	17.17	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	10.79	10.79	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	14.81	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	10.29	10.29	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	10.79	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	9.73	9.73	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	10.29	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	9.51	9.51	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	9.73	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	7.78	7.78	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	9.51	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	6.55	6.55	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	7.78	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.94**	**5.94**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**6.55**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	21.49	21.49	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	23.91	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	21.49	21.49	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.50	6.45	HGL Too High!
P3	DI14	DI13	1.00	21.49	21.49	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.49	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	20.91	20.91	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	21.49	6.58	HGL Too High!
P2	DI2	DI1	1.00	20.86	20.86	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.86	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	20.86	20.86	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	20.86	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	21.42	21.42	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.43	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	21.42	21.42	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	21.75	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	20.45	20.45	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	21.42	8.13	HGL Too High!
P42	DI31	MH22	1.00	17.46	17.46	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	17.48	5.12	HGL Too High!
P43	MH22	DI32	1.00	17.44	17.44	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	17.46	5.45	HGL Too High!
P44	DI32	EX	1.00	17.17	17.17	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	17.44	5.23	HGL Too High!
P46	DI34	DI33	1.00	17.48	17.48	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.48	5.47	HGL Too High!
P45	DI33	DI32	1.00	17.44	17.44	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	17.48	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	10.79	10.79	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	10.79	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	20.57	20.57	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	20.62	3.63	HGL Too High!
P48	DI40	DI41	0.80	20.57	20.57	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.57	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	20.45	20.45	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	20.57	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	13.35	13.35	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.35	7.41	
P5	MH1	MH2	1.20	13.35	13.35	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	13.35	7.93	HGL Too High!
P7	MH2	MH3	1.20	13.34	13.34	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	13.35	7.65	HGL Too High!
P10	MH3	MH4	1.20	13.33	13.33	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	13.34	7.28	HGL Too High!
P13	MH4	MH5	1.20	13.29	13.29	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	13.33	7.09	HGL Too High!
P15	MH5	MH20	1.60	13.23	13.23	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	13.29	7.40	HGL Too High!
P6	DI16	MH2	1.00	13.35	13.35	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.35	7.33	HGL Too High!
P9	DI3	MH3	1.00	13.34	13.34	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.35	6.62	HGL Too High!
P8	DI17	MH3	1.00	13.34	13.34	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.35	6.96	HGL Too High!
P12	DI4	MH4	1.00	13.33	13.33	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.34	6.48	HGL Too High!
P11	DI18	MH4	1.00	13.33	13.33	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.34	6.56	HGL Too High!
P14	DI5	MH5	1.00	13.29	13.29	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.29	6.61	HGL Too High!
P18	DI6	MH6	1.00	13.29	13.29	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.30	7.13	HGL Too High!
P16	MH6	MH5	1.20	13.29	13.29	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	13.29	7.55	HGL Too High!
P17	DI19	MH6	1.00	13.29	13.29	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.29	7.08	HGL Too High!
P32	DI23	MH12	1.00	13.87	13.87	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.88	4.24	HGL Too High!
P31	DI9	MH12	1.00	13.87	13.87	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.87	7.13	HGL Too High!
P30	MH12	MH11	1.60	13.87	13.87	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	13.87	7.48	HGL Too High!
P27	MH11	MH10	1.60	13.85	13.85	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	13.87	7.21	HGL Too High!
P25	MH10	MH9	1.60	13.84	13.84	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	13.85	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.83	13.83	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	13.84	7.85	HGL Too High!
P20	MH8	MH21	1.60	13.81	13.81	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	13.83	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	13.79	13.79	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	13.81	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	13.79	13.79	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	13.81	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	13.83	13.83	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	13.84	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	13.88	13.88	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	13.96	4.78	HGL Too High!
P51	STUB	DI22	1.00	13.88	13.88	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	13.89	7.16	HGL Too High!
P28	DI22	MH11	1.00	13.87	13.87	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	13.88	6.74	HGL Too High!
P29	DI8	MH11	1.00	13.87	13.87	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.87	6.92	HGL Too High!
P26	DI21	MH10	1.00	13.85	13.85	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.85	7.23	HGL Too High!
P23	DI20	MH9	1.00	13.84	13.84	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	13.84	7.38	HGL Too High!
P24	DI7	MH9	1.00	13.84	13.84	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.84	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	24.46	24.46	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.46	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	24.46	24.46	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.46	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	24.41	24.41	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	24.46	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	24.36	24.36	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	24.41	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	24.11	24.11	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	24.36	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	23.95	23.95	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	24.11	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	20.67	20.67	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	23.95	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	18.31	18.31	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	20.67	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	14.29	14.29	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	18.31	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	13.79	13.79	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	14.29	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	13.23	13.23	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	13.79	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	13.01	13.01	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	13.23	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	11.28	11.28	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	13.01	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.05	10.05	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	11.28	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.44**	**9.44**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**10.05**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	24.99	24.99	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	27.41	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	24.99	24.99	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.00	6.45	HGL Too High!
P3	DI14	DI13	1.00	24.99	24.99	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.99	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	24.41	24.41	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	24.99	6.58	HGL Too High!
P2	DI2	DI1	1.00	24.36	24.36	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.36	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	24.36	24.36	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	24.36	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	24.92	24.92	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.93	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	24.92	24.92	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	25.25	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	23.95	23.95	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	24.92	8.13	HGL Too High!
P42	DI31	MH22	1.00	20.96	20.96	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	20.98	5.12	HGL Too High!
P43	MH22	DI32	1.00	20.94	20.94	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	20.96	5.45	HGL Too High!
P44	DI32	EX	1.00	20.67	20.67	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	20.94	5.23	HGL Too High!
P46	DI34	DI33	1.00	20.98	20.98	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.98	5.47	HGL Too High!
P45	DI33	DI32	1.00	20.94	20.94	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	20.98	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	14.29	14.29	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.29	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	24.07	24.07	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	24.12	3.63	HGL Too High!
P48	DI40	DI41	0.80	24.07	24.07	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.07	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	23.95	23.95	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	24.07	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	13.85	13.85	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.85	7.41	
P5	MH1	MH2	1.20	13.85	13.85	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	13.85	7.93	HGL Too High!
P7	MH2	MH3	1.20	13.84	13.84	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	13.85	7.65	HGL Too High!
P10	MH3	MH4	1.20	13.83	13.83	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	13.84	7.28	HGL Too High!
P13	MH4	MH5	1.20	13.79	13.79	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	13.83	7.09	HGL Too High!
P15	MH5	MH20	1.60	13.73	13.73	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	13.79	7.40	HGL Too High!
P6	DI16	MH2	1.00	13.85	13.85	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.85	7.33	HGL Too High!
P9	DI3	MH3	1.00	13.84	13.84	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.85	6.62	HGL Too High!
P8	DI17	MH3	1.00	13.84	13.84	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.85	6.96	HGL Too High!
P12	DI4	MH4	1.00	13.83	13.83	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.84	6.48	HGL Too High!
P11	DI18	MH4	1.00	13.83	13.83	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.84	6.56	HGL Too High!
P14	DI5	MH5	1.00	13.79	13.79	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.79	6.61	HGL Too High!
P18	DI6	MH6	1.00	13.79	13.79	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.80	7.13	HGL Too High!
P16	MH6	MH5	1.20	13.79	13.79	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	13.79	7.55	HGL Too High!
P17	DI19	MH6	1.00	13.79	13.79	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.79	7.08	HGL Too High!
P32	DI23	MH12	1.00	14.37	14.37	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.38	4.24	HGL Too High!
P31	DI9	MH12	1.00	14.37	14.37	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.37	7.13	HGL Too High!
P30	MH12	MH11	1.60	14.37	14.37	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	14.37	7.48	HGL Too High!
P27	MH11	MH10	1.60	14.35	14.35	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	14.37	7.21	HGL Too High!
P25	MH10	MH9	1.60	14.34	14.34	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	14.35	7.54	HGL Too High!
P22	MH9	MH8	1.60	14.33	14.33	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	14.34	7.85	HGL Too High!
P20	MH8	MH21	1.60	14.31	14.31	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	14.33	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	14.29	14.29	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	14.31	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	14.29	14.29	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	14.31	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	14.33	14.33	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	14.34	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	14.38	14.38	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	14.46	4.78	HGL Too High!
P51	STUB	DI22	1.00	14.38	14.38	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	14.39	7.16	HGL Too High!
P28	DI22	MH11	1.00	14.37	14.37	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	14.38	6.74	HGL Too High!
P29	DI8	MH11	1.00	14.37	14.37	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.37	6.92	HGL Too High!
P26	DI21	MH10	1.00	14.35	14.35	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.35	7.23	HGL Too High!
P23	DI20	MH9	1.00	14.34	14.34	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	14.34	7.38	HGL Too High!
P24	DI7	MH9	1.00	14.34	14.34	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.34	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	24.96	24.96	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.96	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	24.96	24.96	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.96	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	24.91	24.91	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	24.96	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	24.86	24.86	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	24.91	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	24.61	24.61	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	24.86	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	24.45	24.45	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	24.61	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	21.17	21.17	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	24.45	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	18.81	18.81	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	21.17	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	14.79	14.79	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	18.81	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	14.29	14.29	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	14.79	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	13.73	13.73	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	14.29	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	13.51	13.51	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	13.73	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	11.78	11.78	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	13.51	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.55	10.55	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	11.78	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.94**	**9.94**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**10.55**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	25.49	25.49	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	27.91	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	25.49	25.49	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.50	6.45	HGL Too High!
P3	DI14	DI13	1.00	25.49	25.49	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.49	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	24.91	24.91	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	25.49	6.58	HGL Too High!
P2	DI2	DI1	1.00	24.86	24.86	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.86	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	24.86	24.86	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	24.86	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	25.42	25.42	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.43	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	25.42	25.42	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	25.75	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	24.45	24.45	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	25.42	8.13	HGL Too High!
P42	DI31	MH22	1.00	21.46	21.46	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	21.48	5.12	HGL Too High!
P43	MH22	DI32	1.00	21.44	21.44	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	21.46	5.45	HGL Too High!
P44	DI32	EX	1.00	21.17	21.17	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	21.44	5.23	HGL Too High!
P46	DI34	DI33	1.00	21.48	21.48	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.48	5.47	HGL Too High!
P45	DI33	DI32	1.00	21.44	21.44	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	21.48	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	14.79	14.79	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.79	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	24.57	24.57	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	24.62	3.63	HGL Too High!
P48	DI40	DI41	0.80	24.57	24.57	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.57	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	24.45	24.45	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	24.57	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	14.25	14.25	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.25	7.41	
P5	MH1	MH2	1.20	14.25	14.25	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	14.25	7.93	HGL Too High!
P7	MH2	MH3	1.20	14.24	14.24	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	14.25	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.23	14.23	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	14.24	7.28	HGL Too High!
P13	MH4	MH5	1.20	14.19	14.19	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	14.23	7.09	HGL Too High!
P15	MH5	MH20	1.60	14.13	14.13	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	14.19	7.40	HGL Too High!
P6	DI16	MH2	1.00	14.25	14.25	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.25	7.33	HGL Too High!
P9	DI3	MH3	1.00	14.24	14.24	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.25	6.62	HGL Too High!
P8	DI17	MH3	1.00	14.24	14.24	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.25	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.23	14.23	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.24	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.23	14.23	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.24	6.56	HGL Too High!
P14	DI5	MH5	1.00	14.19	14.19	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.19	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.19	14.19	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.20	7.13	HGL Too High!
P16	MH6	MH5	1.20	14.19	14.19	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	14.19	7.55	HGL Too High!
P17	DI19	MH6	1.00	14.19	14.19	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.19	7.08	HGL Too High!
P32	DI23	MH12	1.00	14.77	14.77	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.78	4.24	HGL Too High!
P31	DI9	MH12	1.00	14.77	14.77	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.77	7.13	HGL Too High!
P30	MH12	MH11	1.60	14.77	14.77	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	14.77	7.48	HGL Too High!
P27	MH11	MH10	1.60	14.75	14.75	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	14.77	7.21	HGL Too High!
P25	MH10	MH9	1.60	14.74	14.74	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	14.75	7.54	HGL Too High!
P22	MH9	MH8	1.60	14.73	14.73	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	14.74	7.85	HGL Too High!
P20	MH8	MH21	1.60	14.71	14.71	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	14.73	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	14.69	14.69	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	14.71	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	14.69	14.69	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	14.71	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	14.73	14.73	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	14.74	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	14.78	14.78	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	14.86	4.78	HGL Too High!
P51	STUB	DI22	1.00	14.78	14.78	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	14.79	7.16	HGL Too High!
P28	DI22	MH11	1.00	14.77	14.77	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	14.78	6.74	HGL Too High!
P29	DI8	MH11	1.00	14.77	14.77	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.77	6.92	HGL Too High!
P26	DI21	MH10	1.00	14.75	14.75	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.75	7.23	HGL Too High!
P23	DI20	MH9	1.00	14.74	14.74	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	14.74	7.38	HGL Too High!
P24	DI7	MH9	1.00	14.74	14.74	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.74	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	25.36	25.36	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.36	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	25.36	25.36	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.36	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	25.31	25.31	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	25.36	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	25.26	25.26	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	25.31	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	25.01	25.01	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	25.26	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	24.85	24.85	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	25.01	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	21.57	21.57	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	24.85	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	19.21	19.21	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	21.57	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	15.19	15.19	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	19.21	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	14.69	14.69	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	15.19	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	14.13	14.13	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	14.69	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	13.91	13.91	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	14.13	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.18	12.18	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	13.91	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.95	10.95	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	12.18	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.34**	**10.34**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**10.95**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	25.89	25.89	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	28.31	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	25.89	25.89	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.90	6.45	HGL Too High!
P3	DI14	DI13	1.00	25.89	25.89	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.89	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	25.31	25.31	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	25.89	6.58	HGL Too High!
P2	DI2	DI1	1.00	25.26	25.26	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.26	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	____ of ____
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	25.26	25.26	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	25.26	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	25.82	25.82	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.83	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	25.82	25.82	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	26.15	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	24.85	24.85	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	25.82	8.13	HGL Too High!
P42	DI31	MH22	1.00	21.86	21.86	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	21.88	5.12	HGL Too High!
P43	MH22	DI32	1.00	21.84	21.84	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	21.86	5.45	HGL Too High!
P44	DI32	EX	1.00	21.57	21.57	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	21.84	5.23	HGL Too High!
P46	DI34	DI33	1.00	21.88	21.88	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.88	5.47	HGL Too High!
P45	DI33	DI32	1.00	21.84	21.84	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	21.88	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	15.19	15.19	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	15.19	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	24.97	24.97	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	25.02	3.63	HGL Too High!
P48	DI40	DI41	0.80	24.97	24.97	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.97	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	24.85	24.85	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	24.97	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	14.75	14.75	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.75	7.41	
P5	MH1	MH2	1.20	14.75	14.75	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	14.75	7.93	HGL Too High!
P7	MH2	MH3	1.20	14.74	14.74	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	14.75	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.73	14.73	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	14.74	7.28	HGL Too High!
P13	MH4	MH5	1.20	14.69	14.69	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	14.73	7.09	HGL Too High!
P15	MH5	MH20	1.60	14.63	14.63	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	14.69	7.40	HGL Too High!
P6	DI16	MH2	1.00	14.75	14.75	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.75	7.33	HGL Too High!
P9	DI3	MH3	1.00	14.74	14.74	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.75	6.62	HGL Too High!
P8	DI17	MH3	1.00	14.74	14.74	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.75	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.73	14.73	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.74	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.73	14.73	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.74	6.56	HGL Too High!
P14	DI5	MH5	1.00	14.69	14.69	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.69	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.69	14.69	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.70	7.13	HGL Too High!
P16	MH6	MH5	1.20	14.69	14.69	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	14.69	7.55	HGL Too High!
P17	DI19	MH6	1.00	14.69	14.69	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.69	7.08	HGL Too High!
P32	DI23	MH12	1.00	15.27	15.27	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.28	4.24	HGL Too High!
P31	DI9	MH12	1.00	15.27	15.27	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.27	7.13	HGL Too High!
P30	MH12	MH11	1.60	15.27	15.27	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	15.27	7.48	HGL Too High!
P27	MH11	MH10	1.60	15.25	15.25	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	15.27	7.21	HGL Too High!
P25	MH10	MH9	1.60	15.24	15.24	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	15.25	7.54	HGL Too High!
P22	MH9	MH8	1.60	15.23	15.23	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	15.24	7.85	HGL Too High!
P20	MH8	MH21	1.60	15.21	15.21	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	15.23	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	15.19	15.19	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	15.21	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	15.19	15.19	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	15.21	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	15.23	15.23	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	15.24	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	15.28	15.28	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	15.36	4.78	HGL Too High!
P51	STUB	DI22	1.00	15.28	15.28	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	15.29	7.16	HGL Too High!
P28	DI22	MH11	1.00	15.27	15.27	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	15.28	6.74	HGL Too High!
P29	DI8	MH11	1.00	15.27	15.27	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.27	6.92	HGL Too High!
P26	DI21	MH10	1.00	15.25	15.25	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.25	7.23	HGL Too High!
P23	DI20	MH9	1.00	15.24	15.24	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	15.24	7.38	HGL Too High!
P24	DI7	MH9	1.00	15.24	15.24	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.24	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	25.86	25.86	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.86	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	25.86	25.86	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.86	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	25.81	25.81	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	25.86	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	25.76	25.76	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	25.81	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	25.51	25.51	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	25.76	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	25.35	25.35	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	25.51	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	22.07	22.07	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	25.35	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	19.71	19.71	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	22.07	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	15.69	15.69	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	19.71	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	15.19	15.19	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	15.69	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	14.63	14.63	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	15.19	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	14.41	14.41	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	14.63	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.68	12.68	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	14.41	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.45	11.45	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	12.68	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.84**	**10.84**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**11.45**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	26.39	26.39	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	28.81	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	26.39	26.39	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.40	6.45	HGL Too High!
P3	DI14	DI13	1.00	26.39	26.39	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.39	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	25.81	25.81	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	26.39	6.58	HGL Too High!
P2	DI2	DI1	1.00	25.76	25.76	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.76	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	25.76	25.76	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	25.76	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	26.32	26.32	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.33	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	26.32	26.32	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	26.65	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	25.35	25.35	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	26.32	8.13	HGL Too High!
P42	DI31	MH22	1.00	22.36	22.36	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	22.38	5.12	HGL Too High!
P43	MH22	DI32	1.00	22.34	22.34	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	22.36	5.45	HGL Too High!
P44	DI32	EX	1.00	22.07	22.07	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	22.34	5.23	HGL Too High!
P46	DI34	DI33	1.00	22.38	22.38	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.38	5.47	HGL Too High!
P45	DI33	DI32	1.00	22.34	22.34	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	22.38	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	15.69	15.69	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	15.69	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	25.47	25.47	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	25.52	3.63	HGL Too High!
P48	DI40	DI41	0.80	25.47	25.47	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.47	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	25.35	25.35	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	25.47	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	15.45	15.45	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.45	7.41	
P5	MH1	MH2	1.20	15.45	15.45	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	15.45	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.44	15.44	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	15.45	7.65	HGL Too High!
P10	MH3	MH4	1.20	15.43	15.43	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	15.44	7.28	HGL Too High!
P13	MH4	MH5	1.20	15.39	15.39	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	15.43	7.09	HGL Too High!
P15	MH5	MH20	1.60	15.33	15.33	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	15.39	7.40	HGL Too High!
P6	DI16	MH2	1.00	15.45	15.45	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.45	7.33	HGL Too High!
P9	DI3	MH3	1.00	15.44	15.44	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.45	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.44	15.44	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.45	6.96	HGL Too High!
P12	DI4	MH4	1.00	15.43	15.43	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.44	6.48	HGL Too High!
P11	DI18	MH4	1.00	15.43	15.43	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.44	6.56	HGL Too High!
P14	DI5	MH5	1.00	15.39	15.39	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.39	6.61	HGL Too High!
P18	DI6	MH6	1.00	15.39	15.39	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.40	7.13	HGL Too High!
P16	MH6	MH5	1.20	15.39	15.39	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	15.39	7.55	HGL Too High!
P17	DI19	MH6	1.00	15.39	15.39	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.39	7.08	HGL Too High!
P32	DI23	MH12	1.00	15.97	15.97	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.98	4.24	HGL Too High!
P31	DI9	MH12	1.00	15.97	15.97	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.97	7.13	HGL Too High!
P30	MH12	MH11	1.60	15.97	15.97	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	15.97	7.48	HGL Too High!
P27	MH11	MH10	1.60	15.95	15.95	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	15.97	7.21	HGL Too High!
P25	MH10	MH9	1.60	15.94	15.94	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	15.95	7.54	HGL Too High!
P22	MH9	MH8	1.60	15.93	15.93	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	15.94	7.85	HGL Too High!
P20	MH8	MH21	1.60	15.91	15.91	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	15.93	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	15.89	15.89	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	15.91	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	15.89	15.89	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	15.91	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	15.93	15.93	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	15.94	7.34	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	15.98	15.98	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	16.06	4.78	HGL Too High!
P51	STUB	DI22	1.00	15.98	15.98	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	15.99	7.16	HGL Too High!
P28	DI22	MH11	1.00	15.97	15.97	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	15.98	6.74	HGL Too High!
P29	DI8	MH11	1.00	15.97	15.97	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.97	6.92	HGL Too High!
P26	DI21	MH10	1.00	15.95	15.95	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.95	7.23	HGL Too High!
P23	DI20	MH9	1.00	15.94	15.94	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	15.94	7.38	HGL Too High!
P24	DI7	MH9	1.00	15.94	15.94	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.94	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	26.56	26.56	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.56	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	26.56	26.56	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.56	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	26.51	26.51	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	26.56	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	26.46	26.46	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	26.51	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	26.21	26.21	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	26.46	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	26.05	26.05	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	26.21	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	22.77	22.77	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	26.05	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	20.41	20.41	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	22.77	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	16.39	16.39	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	20.41	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	15.89	15.89	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	16.39	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	15.33	15.33	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	15.89	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	15.11	15.11	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	15.33	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.38	13.38	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	15.11	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.15	12.15	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	13.38	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**11.54**	**11.54**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**12.15**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	27.09	27.09	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	29.51	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	27.09	27.09	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.10	6.45	HGL Too High!
P3	DI14	DI13	1.00	27.09	27.09	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.09	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	26.51	26.51	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	27.09	6.58	HGL Too High!
P2	DI2	DI1	1.00	26.46	26.46	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.46	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	26.46	26.46	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	26.46	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	27.02	27.02	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.03	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	27.02	27.02	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	27.35	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	26.05	26.05	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	27.02	8.13	HGL Too High!
P42	DI31	MH22	1.00	23.06	23.06	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	23.08	5.12	HGL Too High!
P43	MH22	DI32	1.00	23.04	23.04	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	23.06	5.45	HGL Too High!
P44	DI32	EX	1.00	22.77	22.77	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	23.04	5.23	HGL Too High!
P46	DI34	DI33	1.00	23.08	23.08	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.08	5.47	HGL Too High!
P45	DI33	DI32	1.00	23.04	23.04	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	23.08	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	16.39	16.39	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	16.39	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	26.17	26.17	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	26.22	3.63	HGL Too High!
P48	DI40	DI41	0.80	26.17	26.17	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.17	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	26.05	26.05	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	26.17	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	15.95	15.95	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.95	7.41	
P5	MH1	MH2	1.20	15.95	15.95	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	15.95	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.94	15.94	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	15.95	7.65	HGL Too High!
P10	MH3	MH4	1.20	15.93	15.93	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	15.94	7.28	HGL Too High!
P13	MH4	MH5	1.20	15.89	15.89	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	15.93	7.09	HGL Too High!
P15	MH5	MH20	1.60	15.83	15.83	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	15.89	7.40	HGL Too High!
P6	DI16	MH2	1.00	15.95	15.95	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.95	7.33	HGL Too High!
P9	DI3	MH3	1.00	15.94	15.94	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.95	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.94	15.94	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.95	6.96	HGL Too High!
P12	DI4	MH4	1.00	15.93	15.93	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.94	6.48	HGL Too High!
P11	DI18	MH4	1.00	15.93	15.93	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.94	6.56	HGL Too High!
P14	DI5	MH5	1.00	15.89	15.89	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.89	6.61	HGL Too High!
P18	DI6	MH6	1.00	15.89	15.89	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.90	7.13	HGL Too High!
P16	MH6	MH5	1.20	15.89	15.89	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	15.89	7.55	HGL Too High!
P17	DI19	MH6	1.00	15.89	15.89	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.89	7.08	HGL Too High!
P32	DI23	MH12	1.00	16.47	16.47	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.48	4.24	HGL Too High!
P31	DI9	MH12	1.00	16.47	16.47	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.47	7.13	HGL Too High!
P30	MH12	MH11	1.60	16.47	16.47	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	16.47	7.48	HGL Too High!
P27	MH11	MH10	1.60	16.45	16.45	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	16.47	7.21	HGL Too High!
P25	MH10	MH9	1.60	16.44	16.44	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	16.45	7.54	HGL Too High!
P22	MH9	MH8	1.60	16.43	16.43	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	16.44	7.85	HGL Too High!
P20	MH8	MH21	1.60	16.41	16.41	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	16.43	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	16.39	16.39	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	16.41	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	16.39	16.39	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	16.41	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	16.43	16.43	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	16.44	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	16.48	16.48	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	16.56	4.78	HGL Too High!
P51	STUB	DI22	1.00	16.48	16.48	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	16.49	7.16	HGL Too High!
P28	DI22	MH11	1.00	16.47	16.47	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	16.48	6.74	HGL Too High!
P29	DI8	MH11	1.00	16.47	16.47	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.47	6.92	HGL Too High!
P26	DI21	MH10	1.00	16.45	16.45	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.45	7.23	HGL Too High!
P23	DI20	MH9	1.00	16.44	16.44	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	16.44	7.38	HGL Too High!
P24	DI7	MH9	1.00	16.44	16.44	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.44	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	27.06	27.06	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.06	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	27.06	27.06	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.06	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	27.01	27.01	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	27.06	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	26.96	26.96	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	27.01	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	26.71	26.71	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	26.96	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	26.55	26.55	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	26.71	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	23.27	23.27	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	26.55	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	20.91	20.91	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	23.27	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	16.89	16.89	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	20.91	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	16.39	16.39	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	16.89	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	15.83	15.83	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	16.39	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	15.61	15.61	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	15.83	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.88	13.88	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	15.61	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.65	12.65	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	13.88	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**12.04**	**12.04**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**12.65**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	27.59	27.59	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	30.01	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	27.59	27.59	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.60	6.45	HGL Too High!
P3	DI14	DI13	1.00	27.59	27.59	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.59	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	27.01	27.01	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	27.59	6.58	HGL Too High!
P2	DI2	DI1	1.00	26.96	26.96	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.96	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	26.96	26.96	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	26.96	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	27.52	27.52	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.53	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	27.52	27.52	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	27.85	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	26.55	26.55	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	27.52	8.13	HGL Too High!
P42	DI31	MH22	1.00	23.56	23.56	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	23.58	5.12	HGL Too High!
P43	MH22	DI32	1.00	23.54	23.54	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	23.56	5.45	HGL Too High!
P44	DI32	EX	1.00	23.27	23.27	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	23.54	5.23	HGL Too High!
P46	DI34	DI33	1.00	23.58	23.58	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.58	5.47	HGL Too High!
P45	DI33	DI32	1.00	23.54	23.54	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	23.58	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	16.89	16.89	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	16.89	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	26.67	26.67	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	26.72	3.63	HGL Too High!
P48	DI40	DI41	0.80	26.67	26.67	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.67	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	26.55	26.55	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	26.67	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	17.25	17.25	15	0.3	0.2	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.25	7.41	
P5	MH1	MH2	1.20	17.25	17.25	18	0.6	0.3	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.2	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	17.25	7.93	HGL Too High!
P7	MH2	MH3	1.20	17.24	17.24	18	0.9	0.5	1	73.8	0.0001	0.00	0	0.00	0.00	0.2	0.1	0.0	0.3	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	17.25	7.65	HGL Too High!
P10	MH3	MH4	1.20	17.23	17.23	18	1.6	0.9	8	53.7	0.0002	0.01	0	0.00	0.00	0.5	0.1	0.1	0.5	0.0	1	0.00	0.00	1.0	0.5	0.00	0.01	17.24	7.28	HGL Too High!
P13	MH4	MH5	1.20	17.19	17.19	18	2.8	1.6	84	59.3	0.0006	0.04	0	0.00	0.01	1.5	1.0	0.8	0.9	0.0	8	0.00	0.02	1.0	0.5	0.01	0.04	17.23	7.09	HGL Too High!
P15	MH5	MH20	1.60	17.13	17.13	24	4.2	1.3	90	104	0.0003	0.03	0	0.00	0.01	4.5	0.6	0.2	1.6	0.0	84	0.03	0.05	1.0	0.5	0.02	0.05	17.19	7.40	HGL Too High!
P6	DI16	MH2	1.00	17.25	17.25	15	0.3	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.25	7.33	HGL Too High!
P9	DI3	MH3	1.00	17.24	17.24	15	0.4	0.3	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.25	6.62	HGL Too High!
P8	DI17	MH3	1.00	17.24	17.24	15	0.4	0.3	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.25	6.96	HGL Too High!
P12	DI4	MH4	1.00	17.23	17.23	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.24	6.48	HGL Too High!
P11	DI18	MH4	1.00	17.23	17.23	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.24	6.56	HGL Too High!
P14	DI5	MH5	1.00	17.19	17.19	15	0.5	0.4	21	22.6	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.19	6.61	HGL Too High!
P18	DI6	MH6	1.00	17.19	17.19	15	0.6	0.5	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.20	7.13	HGL Too High!
P16	MH6	MH5	1.20	17.19	17.19	18	1.1	0.6	86	40	0.0001	0.00	0	0.00	0.00	0.3	0.1	0.0	0.5	0.0	23	0.00	0.00	1.0	0.5	0.00	0.01	17.19	7.55	HGL Too High!
P17	DI19	MH6	1.00	17.19	17.19	15	0.4	0.3	94	33	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.19	7.08	HGL Too High!
P32	DI23	MH12	1.00	17.77	17.77	15	0.5	0.4	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.78	4.24	HGL Too High!
P31	DI9	MH12	1.00	17.77	17.77	15	0.4	0.3	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.77	7.13	HGL Too High!
P30	MH12	MH11	1.60	17.77	17.77	24	0.9	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.1	0.2	0.0	0.4	0.0	64	0.00	0.00	1.0	0.5	0.00	0.00	17.77	7.48	HGL Too High!
P27	MH11	MH10	1.60	17.75	17.75	24	1.9	0.6	5	73.2	0.0003	0.02	0	0.00	0.00	0.3	0.2	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.02	17.77	7.21	HGL Too High!
P25	MH10	MH9	1.60	17.74	17.74	24	2.1	0.7	5	69.7	0.0001	0.00	0	0.00	0.00	1.1	0.1	0.0	0.6	0.0	5	0.00	0.00	1.0	0.5	0.00	0.01	17.75	7.54	HGL Too High!
P22	MH9	MH8	1.60	17.73	17.73	24	2.6	0.8	51	108	0.0001	0.01	0	0.00	0.00	1.4	0.1	0.1	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	17.74	7.85	HGL Too High!
P20	MH8	MH21	1.60	17.71	17.71	24	3.4	1.1	90	57.3	0.0002	0.01	0	0.00	0.00	2.1	0.6	0.0	0.8	0.0	51	0.01	0.01	1.0	0.5	0.01	0.02	17.73	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	17.69	17.69	24	3.3	1.1	21	11.3	0.0002	0.00	0	0.00	0.00	3.6	0.0	0.0	1.1	0.0	90	0.01	0.02	1.0	0.5	0.01	0.01	17.71	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	17.69	17.69	18	2.6	1.5	35	7.75	0.0005	0.00	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.01	17.71	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	17.73	17.73	15	0.9	0.7	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	17.74	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	17.78	17.78	8	0.8	2.2	45	17	0.0035	0.06	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.08	17.86	4.78	HGL Too High!
P51	STUB	DI22	1.00	17.78	17.78	15	1.9	1.5	0	10	0.0007	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.00	0.01	17.79	7.16	HGL Too High!
P28	DI22	MH11	1.00	17.77	17.77	15	0.5	0.4	90	30.3	0.0001	0.00	0	0.00	0.00	2.8	1.7	0.0	1.5	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	17.78	6.74	HGL Too High!
P29	DI8	MH11	1.00	17.77	17.77	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.77	6.92	HGL Too High!
P26	DI21	MH10	1.00	17.75	17.75	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.75	7.23	HGL Too High!
P23	DI20	MH9	1.00	17.74	17.74	15	0.3	0.2	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	17.74	7.38	HGL Too High!
P24	DI7	MH9	1.00	17.74	17.74	15	0.3	0.2	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.74	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	28.36	28.36	15	0.5	0.4	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.36	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	28.36	28.36	15	0.6	0.5	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.36	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	28.31	28.31	15	1.1	0.9	90	154	0.0003	0.04	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	90	0.00	0.01	1.0	0.5	0.00	0.04	28.36	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	28.26	28.26	15	2.7	2.2	90	23	0.0017	0.04	0	0.00	0.02	1.1	2.2	0.0	1.3	0.0	0	0.00	0.03	1.0	0.5	0.01	0.05	28.31	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	28.01	28.01	15	3.2	2.6	0	78	0.0025	0.19	0	0.00	0.03	5.9	0.3	0.0	2.2	0.0	90	0.05	0.11	1.0	0.5	0.05	0.25	28.26	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	27.85	27.85	15	3.2	2.6	0	54	0.0024	0.13	0	0.00	0.03	8.5	0.0	0.0	2.6	0.0	0	0.00	0.06	1.0	0.5	0.03	0.16	28.01	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	24.57	24.57	15	7.0	5.7	0	263	0.0116	3.06	0	0.00	0.13	8.2	10.3	3.7	4.4	0.1	90	0.21	0.43	1.0	0.5	0.22	3.28	27.85	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	22.21	22.21	15	9.7	7.9	0	96	0.0224	2.15	0	0.00	0.24	39.6	12.5	0.0	5.7	0.2	0	0.00	0.42	1.0	0.5	0.21	2.36	24.57	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	18.19	18.19	15	9.4	7.7	60	175	0.0213	3.73	0	0.00	0.23	76.3	0.0	0.0	7.9	0.3	0	0.00	0.57	1.0	0.5	0.28	4.02	22.21	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	17.69	17.69	24	9.0	2.9	84	41	0.0016	0.07	0	0.00	0.03	72.5	0.0	0.0	7.7	0.3	60	0.51	0.87	1.0	0.5	0.43	0.50	18.19	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	17.13	17.13	24	13.8	4.4	13	124	0.0037	0.46	0	0.00	0.07	25.9	3.5	3.9	2.9	0.0	84	0.09	0.21	1.0	0.5	0.10	0.56	17.69	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	16.91	16.91	24	17.2	5.5	78	8	0.0057	0.05	0	0.00	0.12	60.3	0.0	0.0	4.4	0.1	13	0.06	0.28	1.3	0.5	0.18	0.23	17.13	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.18	15.18	24	17.1	5.4	0	252	0.0057	1.44	0	0.00	0.11	93.7	0.0	0.0	5.5	0.2	78	0.31	0.58	1.0	0.5	0.29	1.73	16.91	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.95	13.95	24	15.9	5.1	25	221	0.0049	1.09	0	0.00	0.10	93.0	0.0	0.0	5.4	0.2	0	0.00	0.26	1.0	0.5	0.13	1.22	15.18	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**13.34**	**13.34**	**24**	**15.1**	**4.8**	**0**	**98**	**0.0045**	**0.44**	**0**	**0.00**	**0.09**	**80.5**	**0.0**	**0.0**	**5.1**	**0.1**	**25**	**0.12**	**0.35**	**1.0**	**0.5**	**0.17**	**0.61**	**13.95**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	28.89	28.89	4	0.8	8.9	0	16	0.1419	2.27	0	0.00	0.31	0.0	0.0	0.0	0.0	0.0	0	0.00	0.31	1.0	0.5	0.15	2.42	31.31	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	28.89	28.89	8	0.2	0.6	90	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.90	6.45	HGL Too High!
P3	DI14	DI13	1.00	28.89	28.89	15	0.3	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.89	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	28.31	28.31	15	1.6	1.3	0	15	0.0006	0.01	0	0.00	0.01	0.1	6.9	0.1	8.9	0.4	0	0.00	0.44	1.3	1.0	0.57	0.58	28.89	6.58	HGL Too High!
P2	DI2	DI1	1.00	28.26	28.26	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.26	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	1	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	28.26	28.26	15	0.6	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	28.26	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	28.82	28.82	8	0.1	0.4	104	46	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.83	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	28.82	28.82	12	2.3	2.9	90	87	0.0035	0.30	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.33	29.15	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	27.85	27.85	10	2.4	4.4	90	87	0.0100	0.87	0	0.00	0.07	6.5	0.1	0.0	2.9	0.0	90	0.09	0.21	1.0	0.5	0.10	0.97	28.82	8.13	HGL Too High!
P42	DI31	MH22	1.00	24.86	24.86	15	1.1	0.9	7.5	55.8	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	24.88	5.12	HGL Too High!
P43	MH22	DI32	1.00	24.84	24.84	15	1.1	0.9	80	45.1	0.0002	0.01	0	0.00	0.00	1.0	0.0	0.0	0.9	0.0	7.5	0.00	0.01	1.0	0.5	0.00	0.02	24.86	5.45	HGL Too High!
P44	DI32	EX	1.00	24.57	24.57	15	3.9	3.2	90	59.3	0.0031	0.19	0	0.00	0.04	1.0	2.1	0.0	1.3	0.0	94	0.02	0.07	1.3	1.0	0.09	0.27	24.84	5.23	HGL Too High!
P46	DI34	DI33	1.00	24.88	24.88	15	0.2	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.88	5.47	HGL Too High!
P45	DI33	DI32	1.00	24.84	24.84	15	1.6	1.3	94	48.5	0.0005	0.03	0	0.00	0.01	0.0	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.03	24.88	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	18.19	18.19	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	18.19	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	27.97	27.97	12	1.2	1.5	0	47	0.0009	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.05	28.02	3.63	HGL Too High!
P48	DI40	DI41	0.80	27.97	27.97	12	0.3	0.4	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.97	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	27.85	27.85	12	1.7	2.2	95	41	0.0020	0.08	0	0.00	0.02	0.1	1.8	0.0	1.5	0.0	0	0.00	0.03	1.3	1.0	0.04	0.12	27.97	4.62	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 2 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
MARKET ST RIVER WEST OUTFALL																										
SOUTH SECTION TO 24"																										
P4	DI15	MH1	3244	1216	4460	0.10	0.74	0.08	0.08	6.0	0.00	4.77	0.4	15	27.3	0.012	0.000027	0.005	4.1	5.0	2.0	0.23	6.23	4.49	4.35	Q ok
P5	MH1	MH2	1	0	1	0.00	0.95	0.00	0.16	6.0	6.23	4.73	0.7	18	82.7	0.012	0.000042	0.005	4.5	8.0	2.7	0.51	6.73	4.25	3.84	Q ok
P7	MH2	MH3	1	0	1	0.00	0.95	0.00	0.23	6.0	6.73	4.63	1.1	18	73.8	0.012	0.000091	0.005	4.6	8.1	3.2	0.39	7.12	3.81	3.44	Q ok
P10	MH3	MH4	1	0	1	0.00	0.95	0.00	0.43	6.0	7.12	4.55	2.0	18	53.7	0.012	0.000297	0.005	4.6	8.1	3.7	0.24	7.36	3.34	3.07	Q ok
P13	MH4	MH5	1	0	1	0.00	0.95	0.00	0.75	6.0	7.36	4.49	3.4	18	59.3	0.012	0.000867	0.005	4.3	7.7	4.2	0.23	7.59	2.97	2.70	Q ok
P15	MH5	MH20	1	0	1	0.00	0.95	0.00	1.13	6.0	7.59	4.45	5.0	24	104.1	0.012	0.000421	0.020	11.1	34.8	7.8	0.22	7.82	2.60	0.50	Q ok
P6	DI16	MH2	3400	1275	4675	0.11	0.74	0.08	0.08	6.0	0.00	4.77	0.4	15	29.3	0.012	0.000029	0.005	4.1	5.0	2.4	0.20	6.20	4.06	3.91	Q ok
P9	DI3	MH3	4110	3259	7369	0.17	0.61	0.10	0.10	6.0	0.00	4.77	0.5	15	18.3	0.012	0.000049	0.005	4.0	4.9	2.4	0.13	6.13	3.68	3.59	Q ok
P8	DI17	MH3	3878	2100	5978	0.14	0.68	0.09	0.09	6.0	0.00	4.77	0.4	15	31.3	0.012	0.000040	0.005	4.2	5.2	2.5	0.21	6.21	3.71	3.54	Q ok
P12	DI4	MH4	7109	2561	9670	0.22	0.75	0.17	0.17	6.0	0.00	6.73	1.1	15	20.1	0.012	0.000254	0.005	4.0	4.9	3.3	0.10	6.10	3.48	3.38	Q ok
P11	DI18	MH4	6435	2210	8645	0.20	0.75	0.15	0.15	6.0	0.00	6.70	1.0	15	28.4	0.012	0.000205	0.005	4.1	5.1	3.1	0.15	6.15	3.48	3.33	Q ok
P14	DI5	MH5	4974	2549	7523	0.17	0.69	0.12	0.12	6.0	0.00	4.77	0.6	15	22.6	0.012	0.000066	0.005	4.0	4.9	2.4	0.16	6.16	3.68	3.57	Q ok
P18	DI6	MH6	6937	1863	8800	0.20	0.79	0.16	0.16	6.0	0.00	4.77	0.8	15	38.0	0.012	0.000117	0.005	4.0	4.9	2.8	0.22	6.22	4.57	4.38	Q ok
P16	MH6	MH5	1	0	1	0.00	0.95	0.00	0.27	6.0	6.22	4.73	1.3	18	40.0	0.012	0.000121	0.011	6.8	12.1	4.1	0.16	6.39	3.77	3.32	Q ok
P17	DI19	MH6	4542	1703	6245	0.14	0.74	0.11	0.11	6.0	0.00	4.77	0.5	15	33.0	0.012	0.000052	0.005	4.0	4.9	2.4	0.23	6.23	4.19	4.02	Q ok
NORTH SECTION TO 24"																										
P32	DI23	MH12	5495	1914	7409	0.17	0.75	0.13	0.13	6.0	0.00	4.77	0.6	15	33.31	0.012	0.0001	0.005	4.1	5.0	2.4	0.23	6.23	3.98	3.81	Q ok
P31	DI9	MH12	4483	551	5034	0.12	0.87	0.10	0.10	6.0	0.00	4.77	0.5	15	18.3	0.012	0.0000	0.005	4.0	4.9	2.4	0.13	6.13	3.86	3.77	Q ok
P30	MH12	MH11	1	0	1	0.00	0.95	0.00	0.23	6.0	6.23	4.73	1.1	18	50.1	0.012	0.0001	0.005	4.5	8.0	3.2	0.26	6.49	3.67	3.42	Q ok
P27	MH11	MH10	1	0	1	0.00	0.95	0.00	0.47	6.0	6.49	4.67	2.2	18	73.2	0.012	0.0004	0.005	4.6	8.1	3.8	0.32	6.81	3.39	3.02	Q ok
P25	MH10	MH9	1	0	1	0.00	0.95	0.00	0.54	6.0	6.81	4.61	2.5	24	69.68	0.012	0.0001	0.006	6.3	19.7	4.4	0.26	7.08	2.92	2.47	Q ok
P22	MH9	MH8	1	0	1	0.00	0.95	0.00	0.68	6.0	7.08	4.55	3.1	24	108.3	0.012	0.0002	0.005	5.5	17.3	4.1	0.44	7.52	2.47	1.93	Q ok
P20	MH8	MH21	1	0	1	0.00	0.95	0.00	0.90	6.0	7.52	4.47	4.0	24	57.3	0.012	0.0003	0.021	11.4	35.8	6.8	0.14	7.66	1.65	0.43	Q ok
P21	MH21	EXMH1	1	0	1	0.00	0.95	0.00	0.90	6.0	7.66	4.43	4.0	24	11.3	0.012	0.0003	0.005	5.7	17.9	4.3	0.04	7.70	0.33	0.27	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 2 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P47	DI35	EXMH1	29988	0	29988	0.69	0.95	0.65	0.65	6.0	0.00	4.77	3.1	18	7.75	0.012	0.0008	0.008	5.8	10.3	4.9	0.03	6.03	-0.50	-0.56	Q ok
P-80	DI-80	MH-08	9967	0	9967	0.23	0.95	0.22	0.22	6.0	0.00	4.77	1.0	15	49	0.012	0.0002	0.009	5.5	6.8	3.9	0.21	6.21	4.53	4.07	Q ok
P52	TDI50	DI22	8815	0	8815	0.20	0.95	0.19	0.19	6.0	0.00	4.77	0.9	8	17	0.012	0.0049	0.010	3.8	1.3	4.1	0.07	6.07	3.92	3.75	Q ok
P51	STUB	DI22	21322	0	21322	0.49	0.95	0.47	0.47	6.0	0.00	4.77	2.2	15	10.02	0.012	0.0010	0.005	4.0	4.9	3.9	0.04	6.04	3.79	3.74	Q ok
P28	DI22	MH11	5555	1955	7510	0.17	0.75	0.13	0.13	6.0	0.00	4.77	0.6	15	30.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.18	6.18	3.64	3.49	Q ok
P29	DI8	MH11	5120	570	5690	0.13	0.87	0.11	0.11	6.0	0.00	4.77	0.5	15	18.3	0.012	0.0001	0.005	4.0	4.9	2.4	0.13	6.13	3.64	3.55	Q ok
P26	DI21	MH10	2755	930	3685	0.08	0.76	0.06	0.06	6.0	0.00	4.77	0.3	15	18.3	0.012	0.0000	0.005	4.0	4.9	2.0	0.16	6.16	4.02	3.93	Q ok
P23	DI20	MH9	3213	1102	4315	0.10	0.75	0.07	0.07	6.0	0.00	4.77	0.4	15	29.3	0.012	0.0000	0.005	4.0	4.9	2.0	0.25	6.25	4.53	4.38	Q ok
P24	DI7	MH9	3164	527	3691	0.08	0.84	0.07	0.07	6.0	0.00	4.77	0.3	15	28.02	0.012	0.0000	0.005	4.0	4.9	2.0	0.24	6.24	4.38	4.24	Q ok
SOUTH SECTION LOW TRUNK TO 24" OUTFALL																										
CRB-P72	CRB-DI72	CRB-MH-74	6086	0	6086	0.14	0.95	0.13	0.13	6.0	0.00	4.77	0.6	15	16	0.012	0.0001	0.019	7.8	9.6	3.8	0.07	6.07	2.60	2.30	Q ok
CRB-P73	CRB-DI73	CRB-MH-74	7042	0	7042	0.16	0.95	0.15	0.15	6.0	0.00	4.77	0.7	15	34	0.012	0.0001	0.005	4.0	4.9	2.8	0.20	6.20	1.92	1.75	Q ok
CRB-P74	CRB-MH-74	CRB-MH-67	1	0	1	0.00	0.95	0.00	0.29	6.0	6.20	4.73	1.4	15	154	0.012	0.0004	0.005	4.1	5.1	3.4	0.76	6.96	1.65	0.84	Q ok
EXP2	CRB-MH-67	EXMH3	1	0	1	0.00	0.95	0.00	0.70	6.0	6.96	4.57	3.2	15	23	0.013	0.0025	***0.003***	***2.7***	3.3	3.1	0.12	7.08	-1.14	-1.20	Q ok
EXP3	EXMH3	EXMH4	1	0	1	0.00	0.95	0.00	0.85	6.0	7.08	4.55	3.9	15	78	0.013	0.0036	***0.003***	***2.7***	3.3	2.2	0.59	7.67	-1.20	-1.40	Undersized!
EXP4	EXMH4	EXMH5	1	0	1	0.00	0.95	0.00	0.85	6.0	7.67	4.43	3.8	15	54	0.013	0.0034	***0.003***	***2.7***	3.3	2.2	0.41	8.08	-1.40	-1.54	Undersized!
EXP5	EXMH5	EXMH6	1	0	1	0.00	0.95	0.00	1.89	6.0	8.08	4.35	8.2	15	263	0.013	0.0161	***0.003***	***2.7***	3.3	2.2	2.00	10.08	-1.54	-2.22	Undersized!
EXP6	EXMH6	EXMH7	1	0	1	0.00	0.95	0.00	2.88	6.0	10.08	3.96	11.4	15	96	0.013	0.0312	***0.003***	***2.7***	3.3	2.2	0.73	10.81	-2.22	-2.47	Undersized!
EXP7	EXMH7	EXMH8	1	0	1	0.00	0.95	0.00	2.88	6.0	10.81	3.87	11.1	15	175	0.013	0.0298	***0.003***	***2.7***	3.3	2.2	1.33	12.14	-2.47	-2.92	Undersized!
EXP8	EXMH8	EXMH9	1	0	1	0.00	0.95	0.00	2.88	6.0	12.14	3.70	10.7	24	41	0.013	0.0022	0.009	6.8	21.4	6.8	0.10	12.24	-2.92	-3.29	Q ok
EXP9	EXMH9	EXMH10	1	0	1	0.00	0.95	0.00	4.43	6.0	12.24	3.69	16.4	24	124	0.013	0.0052	0.009	6.8	21.4	7.6	0.27	12.51	-3.29	-4.40	Q ok
EXP10	EXMH10	EXMH11	1	0	1	0.00	0.95	0.00	5.57	6.0	12.51	3.65	20.3	24	8	0.013	0.0081	***0.001***	***2.7***	8.5	2.2	0.06	12.57	-4.40	-4.41	Undersized!
EXP11	EXMH11	EXMH12	1	0	1	0.00	0.95	0.00	5.57	6.0	12.57	3.64	20.2	24	252	0.013	0.0080	***0.001***	***2.7***	8.5	2.2	1.90	14.47	-4.41	-4.76	Undersized!
EXP12	EXMH12	EXMH13	1	0	1	0.00	0.95	0.00	5.57	6.0	14.47	3.39	18.9	24	221	0.013	0.0070	***0.001***	***2.7***	8.5	2.2	1.67	16.14	-4.76	-5.07	Undersized!
EXP13	**EXMH13**	**OUTFALL**	**1**	**0**	**1**	**0.00**	0.95	**0.00**	**5.57**	**6.0**	**16.14**	3.25	18.1	**24**	**98**	**0.013**	**0.0064**	***0.001***	***2.7***	**8.5**	**2.2**	**0.74**	**16.88**	**-5.07**	**-5.21**	**Undersized!**
ROOF	COLLINS	MSS DI-13	8875	0	8875	0.20	0.95	0.19	0.19	6.0	0.00	4.77	0.9	4	16	0.012	0.2005	0.019	3.2	0.3	2.7	0.10	6.10	2.60	2.30	Undersized!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 2 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
CRB-P75	TD-03	MSS DI-13	2341	0	2341	0.05	0.95	0.05	0.05	6.0	0.00	4.77	**0.24**	8	33	0.011	0.000291	0.0348	7.6	**2.7**	4.6	0.12	6.12	4.57	3.42	Q ok
P3	DI14	DI13	3876	441	4317	0.10	0.87	0.09	0.09	6.0	0.00	4.77	0.4	15	69.3	0.012	0.0000	0.005	4.0	4.9	2.4	0.48	6.48	4.03	3.68	Q ok
EXP1	DI13	MH67	3876	441	4317	0.10	0.87	0.09	0.42	6.0	6.48	4.67	1.9	15	15	0.013	0.0009	***0.003***	***2.7***	3.3	2.8	0.09	6.57	-1.10	-1.14	Q ok
P2	DI2	DI1	3846	1139	4985	0.11	0.77	0.09	0.09	6.0	0.00	4.77	0.4	15	69.3	0.012	0.0000	0.005	4.0	4.9	2.4	0.48	6.48	4.03	3.68	Q ok
P1	DI1	EXMH	2301	1082	3383	0.08	0.70	0.05	0.14	6.0	6.48	4.67	0.7	15	3.34	0.012	0.0001	0.005	4.0	4.9	2.8	0.02	6.50	3.39	3.37	Q ok
CRB-P84	TD-04	EXMH	1667	0	1667	0.04	0.95	0.04	0.04	6.0	0.00	4.77	**0.17**	8	46	0.011	0.000147	0.0383	8.0	**2.8**	3.9	0.20	6.20	6.26	4.50	Q ok
EXP15	EXDI	EXMH	24757	6130	30887	0.71	0.80	0.57	0.57	6.0	0.00	4.77	**2.70**	12	87	0.012	0.004880	0.0049	3.5	**2.7**	4.0	0.36	6.36	2.00	1.57	Q ok
EXP16	EXMH	EXMH5	1	0	1	0.00	0.95	0.00	0.60	6.0	6.36	4.69	**2.82**	10	87	0.012	0.014132	0.0049	3.1	**1.7**	2.5	0.58	6.94	2.00	1.57	Undersized!
P42	DI31	MH22	12796.5	0	12797	0.29	0.95	0.28	0.28	6.0	0.00	4.77	1.3	15	55.8	0.012	0.0004	0.005	4.0	5.0	3.3	0.28	6.28	2.00	1.72	Q ok
P43	MH22	DI32	1	0	1	0.00	0.95	0.00	0.28	6.0	6.28	4.71	1.3	15	45.1	0.012	0.0004	0.005	4.1	5.0	3.3	0.23	6.51	1.62	1.39	Q ok
P44	DI32	EX	14459.5	0	14460	0.33	0.95	0.32	1.00	6.0	6.51	4.67	4.6	15	59.3	0.012	0.0044	0.030	9.9	12.1	9.1	0.11	6.61	1.29	0.70	Q ok
P46	DI34	DI33	2420	0	2420	0.06	0.95	0.05	0.05	6.0	0.00	4.77	0.3	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.0	0.32	6.32	2.00	1.82	Q ok
P45	DI33	DI32	15975	0	15975	0.37	0.95	0.35	0.40	6.0	6.32	4.71	1.9	15	48.5	0.012	0.0007	0.007	4.7	5.8	4.2	0.19	6.51	1.72	1.39	Q ok
EXP17	EXMH	EXMH8	1	0	1	0.00	0.95	0.00	0.00	6.0	0.00	4.77	0.0	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.0	0.32	6.32	2.00	1.82	Q ok
EX-P LOT	EXDI LOT	DI-MSS-41	13430	0	13430	0.31	0.95	0.29	0.29	6.0	0.00	4.77	**1.40**	12	47	0.012	0.001310	0.0074	4.2	**3.3**	3.9	0.20	6.20	2.50	2.15	Q ok
P48	DI40	DI41	3590	0	3590	0.08	0.95	0.08	0.08	6.0	0.00	4.77	0.4	12	82.1	0.012	0.0001	0.005	3.5	2.7	2.4	0.56	6.56	2.56	2.15	Q ok
P-MSS-48A	DI-MSS-41	EX-MH LOW	3072	0	3072	0.07	0.95	0.07	0.44	6.0	6.56	4.65	**2.04**	12	41	0.012	0.002787	0.0051	3.5	**2.8**	3.9	0.18	6.74	2.05	1.84	Q ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	8.71	8.71	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.72	7.41	
P5	MH1	MH2	1.20	8.71	8.71	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	8.71	7.93	HGL Too High!
P7	MH2	MH3	1.20	8.70	8.70	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	8.71	7.65	HGL Too High!
P10	MH3	MH4	1.20	8.68	8.68	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	8.70	7.28	HGL Too High!
P13	MH4	MH5	1.20	8.62	8.62	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	8.68	7.09	HGL Too High!
P15	MH5	MH20	1.60	8.54	8.54	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	8.62	7.40	HGL Too High!
P6	DI16	MH2	1.00	8.71	8.71	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.71	7.33	HGL Too High!
P9	DI3	MH3	1.00	8.70	8.70	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.70	6.62	HGL Too High!
P8	DI17	MH3	1.00	8.70	8.70	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.70	6.96	HGL Too High!
P12	DI4	MH4	1.00	8.68	8.68	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.69	6.48	HGL Too High!
P11	DI18	MH4	1.00	8.68	8.68	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.69	6.56	HGL Too High!
P14	DI5	MH5	1.00	8.62	8.62	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.62	6.61	HGL Too High!
P18	DI6	MH6	1.00	8.63	8.63	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.63	7.13	HGL Too High!
P16	MH6	MH5	1.20	8.62	8.62	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	8.63	7.55	HGL Too High!
P17	DI19	MH6	1.00	8.63	8.63	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.63	7.08	HGL Too High!
P32	DI23	MH12	1.00	9.45	9.45	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.45	4.24	HGL Too High!
P31	DI9	MH12	1.00	9.45	9.45	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.45	7.13	HGL Too High!
P30	MH12	MH11	1.60	9.44	9.44	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	9.45	7.48	HGL Too High!
P27	MH11	MH10	1.60	9.41	9.41	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	9.44	7.21	HGL Too High!
P25	MH10	MH9	1.60	9.40	9.40	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	9.41	7.54	HGL Too High!
P22	MH9	MH8	1.60	9.38	9.38	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	9.40	7.85	HGL Too High!
P20	MH8	MH21	1.60	9.35	9.35	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	9.38	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	9.34	9.34	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	9.35	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	9.34	9.34	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	9.35	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	9.38	9.38	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	9.39	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	9.46	9.46	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	9.57	4.78	HGL Too High!
P51	STUB	DI22	1.00	9.46	9.46	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	9.48	7.16	HGL Too High!
P28	DI22	MH11	1.00	9.44	9.44	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	9.46	6.74	HGL Too High!
P29	DI8	MH11	1.00	9.44	9.44	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.44	6.92	HGL Too High!
P26	DI21	MH10	1.00	9.41	9.41	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.41	7.23	HGL Too High!
P23	DI20	MH9	1.00	9.40	9.40	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	9.40	7.38	HGL Too High!
P24	DI7	MH9	1.00	9.40	9.40	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.40	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	24.19	24.19	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.19	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	24.19	24.19	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.20	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	24.13	24.13	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	24.19	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	24.05	24.05	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	24.13	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	23.70	23.70	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	24.05	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	23.47	23.47	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	23.70	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	18.92	18.92	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	23.47	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	15.64	15.64	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	18.92	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	10.03	10.03	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	15.64	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	9.34	9.34	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	10.03	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	8.54	8.54	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	9.34	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	8.22	8.22	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	8.54	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	5.80	5.80	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	8.22	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	4.08	4.08	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	5.80	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.20**	**3.20**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**4.08**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	24.95	24.95	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	28.37	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	24.95	24.95	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.96	6.45	HGL Too High!
P3	DI14	DI13	1.00	24.95	24.95	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.95	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	24.13	24.13	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	24.95	6.58	HGL Too High!
P2	DI2	DI1	1.00	24.06	24.06	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.06	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	24.05	24.05	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	24.06	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	24.85	24.85	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.86	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	24.85	24.85	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	25.32	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	23.47	23.47	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	24.85	8.13	HGL Too High!
P42	DI31	MH22	1.00	19.33	19.33	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	19.35	5.12	HGL Too High!
P43	MH22	DI32	1.00	19.31	19.31	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	19.33	5.45	HGL Too High!
P44	DI32	EX	1.00	18.92	18.92	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	19.31	5.23	HGL Too High!
P46	DI34	DI33	1.00	19.35	19.35	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.35	5.47	HGL Too High!
P45	DI33	DI32	1.00	19.31	19.31	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	19.35	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	10.03	10.03	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	10.03	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	23.64	23.64	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	23.72	3.63	HGL Too High!
P48	DI40	DI41	0.80	23.64	23.64	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.65	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	23.47	23.47	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	23.64	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	8.91	8.91	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.92	7.41	
P5	MH1	MH2	1.20	8.91	8.91	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	8.91	7.93	HGL Too High!
P7	MH2	MH3	1.20	8.90	8.90	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	8.91	7.65	HGL Too High!
P10	MH3	MH4	1.20	8.88	8.88	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	8.90	7.28	HGL Too High!
P13	MH4	MH5	1.20	8.82	8.82	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	8.88	7.09	HGL Too High!
P15	MH5	MH20	1.60	8.74	8.74	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	8.82	7.40	HGL Too High!
P6	DI16	MH2	1.00	8.91	8.91	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.91	7.33	HGL Too High!
P9	DI3	MH3	1.00	8.90	8.90	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.90	6.62	HGL Too High!
P8	DI17	MH3	1.00	8.90	8.90	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.90	6.96	HGL Too High!
P12	DI4	MH4	1.00	8.88	8.88	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.89	6.48	HGL Too High!
P11	DI18	MH4	1.00	8.88	8.88	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.89	6.56	HGL Too High!
P14	DI5	MH5	1.00	8.82	8.82	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.82	6.61	HGL Too High!
P18	DI6	MH6	1.00	8.83	8.83	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	8.83	7.13	HGL Too High!
P16	MH6	MH5	1.20	8.82	8.82	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	8.83	7.55	HGL Too High!
P17	DI19	MH6	1.00	8.83	8.83	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	8.83	7.08	HGL Too High!
P32	DI23	MH12	1.00	9.65	9.65	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.65	4.24	HGL Too High!
P31	DI9	MH12	1.00	9.65	9.65	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.65	7.13	HGL Too High!
P30	MH12	MH11	1.60	9.64	9.64	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	9.65	7.48	HGL Too High!
P27	MH11	MH10	1.60	9.61	9.61	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	9.64	7.21	HGL Too High!
P25	MH10	MH9	1.60	9.60	9.60	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	9.61	7.54	HGL Too High!
P22	MH9	MH8	1.60	9.58	9.58	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	9.60	7.85	HGL Too High!
P20	MH8	MH21	1.60	9.55	9.55	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	9.58	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	9.54	9.54	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	9.55	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	9.54	9.54	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	9.55	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	9.58	9.58	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	9.59	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	9.66	9.66	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	9.77	4.78	HGL Too High!
P51	STUB	DI22	1.00	9.66	9.66	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	9.68	7.16	HGL Too High!
P28	DI22	MH11	1.00	9.64	9.64	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	9.66	6.74	HGL Too High!
P29	DI8	MH11	1.00	9.64	9.64	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.64	6.92	HGL Too High!
P26	DI21	MH10	1.00	9.61	9.61	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.61	7.23	HGL Too High!
P23	DI20	MH9	1.00	9.60	9.60	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	9.60	7.38	HGL Too High!
P24	DI7	MH9	1.00	9.60	9.60	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	9.60	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	24.39	24.39	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.39	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	24.39	24.39	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.40	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	24.33	24.33	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	24.39	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	24.25	24.25	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	24.33	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	23.90	23.90	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	24.25	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	23.67	23.67	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	23.90	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	19.12	19.12	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	23.67	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	15.84	15.84	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	19.12	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	10.23	10.23	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	15.84	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	9.54	9.54	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	10.23	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	8.74	8.74	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	9.54	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	8.42	8.42	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	8.74	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	6.00	6.00	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	8.42	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	4.28	4.28	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	6.00	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.40**	**3.40**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**4.28**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	25.15	25.15	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	28.57	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	25.15	25.15	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.16	6.45	HGL Too High!
P3	DI14	DI13	1.00	25.15	25.15	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.15	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	24.33	24.33	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	25.15	6.58	HGL Too High!
P2	DI2	DI1	1.00	24.26	24.26	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.26	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	24.25	24.25	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	24.26	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	25.05	25.05	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.06	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	25.05	25.05	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	25.52	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	23.67	23.67	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	25.05	8.13	HGL Too High!
P42	DI31	MH22	1.00	19.53	19.53	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	19.55	5.12	HGL Too High!
P43	MH22	DI32	1.00	19.51	19.51	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	19.53	5.45	HGL Too High!
P44	DI32	EX	1.00	19.12	19.12	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	19.51	5.23	HGL Too High!
P46	DI34	DI33	1.00	19.55	19.55	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.55	5.47	HGL Too High!
P45	DI33	DI32	1.00	19.51	19.51	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	19.55	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	10.23	10.23	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	10.23	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	23.84	23.84	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	23.92	3.63	HGL Too High!
P48	DI40	DI41	0.80	23.84	23.84	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.85	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	23.67	23.67	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	23.84	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	12.41	12.41	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.42	7.41	
P5	MH1	MH2	1.20	12.41	12.41	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	12.41	7.93	HGL Too High!
P7	MH2	MH3	1.20	12.40	12.40	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	12.41	7.65	HGL Too High!
P10	MH3	MH4	1.20	12.38	12.38	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	12.40	7.28	HGL Too High!
P13	MH4	MH5	1.20	12.32	12.32	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	12.38	7.09	HGL Too High!
P15	MH5	MH20	1.60	12.24	12.24	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	12.32	7.40	HGL Too High!
P6	DI16	MH2	1.00	12.41	12.41	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.41	7.33	HGL Too High!
P9	DI3	MH3	1.00	12.40	12.40	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.40	6.62	HGL Too High!
P8	DI17	MH3	1.00	12.40	12.40	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.40	6.96	HGL Too High!
P12	DI4	MH4	1.00	12.38	12.38	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.39	6.48	HGL Too High!
P11	DI18	MH4	1.00	12.38	12.38	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.39	6.56	HGL Too High!
P14	DI5	MH5	1.00	12.32	12.32	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.32	6.61	HGL Too High!
P18	DI6	MH6	1.00	12.33	12.33	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.33	7.13	HGL Too High!
P16	MH6	MH5	1.20	12.32	12.32	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	12.33	7.55	HGL Too High!
P17	DI19	MH6	1.00	12.33	12.33	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.33	7.08	HGL Too High!
P32	DI23	MH12	1.00	13.15	13.15	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.15	4.24	HGL Too High!
P31	DI9	MH12	1.00	13.15	13.15	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.15	7.13	HGL Too High!
P30	MH12	MH11	1.60	13.14	13.14	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	13.15	7.48	HGL Too High!
P27	MH11	MH10	1.60	13.11	13.11	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	13.14	7.21	HGL Too High!
P25	MH10	MH9	1.60	13.10	13.10	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	13.11	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.08	13.08	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	13.10	7.85	HGL Too High!
P20	MH8	MH21	1.60	13.05	13.05	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	13.08	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	13.04	13.04	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	13.05	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	13.04	13.04	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	13.05	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	13.08	13.08	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	13.09	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	13.16	13.16	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	13.27	4.78	HGL Too High!
P51	STUB	DI22	1.00	13.16	13.16	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	13.18	7.16	HGL Too High!
P28	DI22	MH11	1.00	13.14	13.14	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	13.16	6.74	HGL Too High!
P29	DI8	MH11	1.00	13.14	13.14	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.14	6.92	HGL Too High!
P26	DI21	MH10	1.00	13.11	13.11	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.11	7.23	HGL Too High!
P23	DI20	MH9	1.00	13.10	13.10	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	13.10	7.38	HGL Too High!
P24	DI7	MH9	1.00	13.10	13.10	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.10	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	27.89	27.89	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.89	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	27.89	27.89	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.90	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	27.83	27.83	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	27.89	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	27.75	27.75	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	27.83	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	27.40	27.40	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	27.75	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	27.17	27.17	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	27.40	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	22.62	22.62	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	27.17	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	19.34	19.34	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	22.62	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	13.73	13.73	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	19.34	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	13.04	13.04	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	13.73	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	12.24	12.24	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	13.04	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	11.92	11.92	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	12.24	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	9.50	9.50	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	11.92	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	7.78	7.78	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	9.50	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**6.90**	**6.90**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**7.78**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	28.65	28.65	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	32.07	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	28.65	28.65	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.66	6.45	HGL Too High!
P3	DI14	DI13	1.00	28.65	28.65	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.65	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	27.83	27.83	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	28.65	6.58	HGL Too High!
P2	DI2	DI1	1.00	27.76	27.76	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.76	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	27.75	27.75	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	27.76	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	28.55	28.55	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.56	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	28.55	28.55	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	29.02	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	27.17	27.17	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	28.55	8.13	HGL Too High!
P42	DI31	MH22	1.00	23.03	23.03	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	23.05	5.12	HGL Too High!
P43	MH22	DI32	1.00	23.01	23.01	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	23.03	5.45	HGL Too High!
P44	DI32	EX	1.00	22.62	22.62	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	23.01	5.23	HGL Too High!
P46	DI34	DI33	1.00	23.05	23.05	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.05	5.47	HGL Too High!
P45	DI33	DI32	1.00	23.01	23.01	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	23.05	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	13.73	13.73	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	13.73	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	27.34	27.34	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	27.42	3.63	HGL Too High!
P48	DI40	DI41	0.80	27.34	27.34	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.35	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	27.17	27.17	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	27.34	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	12.91	12.91	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.92	7.41	
P5	MH1	MH2	1.20	12.91	12.91	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	12.91	7.93	HGL Too High!
P7	MH2	MH3	1.20	12.90	12.90	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	12.91	7.65	HGL Too High!
P10	MH3	MH4	1.20	12.88	12.88	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	12.90	7.28	HGL Too High!
P13	MH4	MH5	1.20	12.82	12.82	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	12.88	7.09	HGL Too High!
P15	MH5	MH20	1.60	12.74	12.74	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	12.82	7.40	HGL Too High!
P6	DI16	MH2	1.00	12.91	12.91	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.91	7.33	HGL Too High!
P9	DI3	MH3	1.00	12.90	12.90	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.90	6.62	HGL Too High!
P8	DI17	MH3	1.00	12.90	12.90	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.90	6.96	HGL Too High!
P12	DI4	MH4	1.00	12.88	12.88	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.89	6.48	HGL Too High!
P11	DI18	MH4	1.00	12.88	12.88	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.89	6.56	HGL Too High!
P14	DI5	MH5	1.00	12.82	12.82	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.82	6.61	HGL Too High!
P18	DI6	MH6	1.00	12.83	12.83	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.83	7.13	HGL Too High!
P16	MH6	MH5	1.20	12.82	12.82	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	12.83	7.55	HGL Too High!
P17	DI19	MH6	1.00	12.83	12.83	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.83	7.08	HGL Too High!
P32	DI23	MH12	1.00	13.65	13.65	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.65	4.24	HGL Too High!
P31	DI9	MH12	1.00	13.65	13.65	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.65	7.13	HGL Too High!
P30	MH12	MH11	1.60	13.64	13.64	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	13.65	7.48	HGL Too High!
P27	MH11	MH10	1.60	13.61	13.61	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	13.64	7.21	HGL Too High!
P25	MH10	MH9	1.60	13.60	13.60	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	13.61	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.58	13.58	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	13.60	7.85	HGL Too High!
P20	MH8	MH21	1.60	13.55	13.55	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	13.58	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	13.54	13.54	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	13.55	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	13.54	13.54	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	13.55	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	13.58	13.58	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	13.59	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	13.66	13.66	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	13.77	4.78	HGL Too High!
P51	STUB	DI22	1.00	13.66	13.66	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	13.68	7.16	HGL Too High!
P28	DI22	MH11	1.00	13.64	13.64	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	13.66	6.74	HGL Too High!
P29	DI8	MH11	1.00	13.64	13.64	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.64	6.92	HGL Too High!
P26	DI21	MH10	1.00	13.61	13.61	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.61	7.23	HGL Too High!
P23	DI20	MH9	1.00	13.60	13.60	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	13.60	7.38	HGL Too High!
P24	DI7	MH9	1.00	13.60	13.60	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.60	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	28.39	28.39	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.39	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	28.39	28.39	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.40	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	28.33	28.33	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	28.39	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	28.25	28.25	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	28.33	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	27.90	27.90	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	28.25	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	27.67	27.67	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	27.90	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	23.12	23.12	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	27.67	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	19.84	19.84	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	23.12	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	14.23	14.23	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	19.84	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	13.54	13.54	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	14.23	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	12.74	12.74	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	13.54	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	12.42	12.42	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	12.74	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	10.00	10.00	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	12.42	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	8.28	8.28	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	10.00	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.40**	**7.40**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**8.28**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	29.15	29.15	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	32.57	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	29.15	29.15	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.16	6.45	HGL Too High!
P3	DI14	DI13	1.00	29.15	29.15	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.15	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	28.33	28.33	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	29.15	6.58	HGL Too High!
P2	DI2	DI1	1.00	28.26	28.26	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.26	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	28.25	28.25	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	28.26	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	29.05	29.05	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.06	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	29.05	29.05	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	29.52	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	27.67	27.67	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	29.05	8.13	HGL Too High!
P42	DI31	MH22	1.00	23.53	23.53	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	23.55	5.12	HGL Too High!
P43	MH22	DI32	1.00	23.51	23.51	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	23.53	5.45	HGL Too High!
P44	DI32	EX	1.00	23.12	23.12	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	23.51	5.23	HGL Too High!
P46	DI34	DI33	1.00	23.55	23.55	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.55	5.47	HGL Too High!
P45	DI33	DI32	1.00	23.51	23.51	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	23.55	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	14.23	14.23	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.23	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	27.84	27.84	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	27.92	3.63	HGL Too High!
P48	DI40	DI41	0.80	27.84	27.84	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.85	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	27.67	27.67	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	27.84	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	13.31	13.31	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.32	7.41	
P5	MH1	MH2	1.20	13.31	13.31	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	13.31	7.93	HGL Too High!
P7	MH2	MH3	1.20	13.30	13.30	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	13.31	7.65	HGL Too High!
P10	MH3	MH4	1.20	13.28	13.28	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	13.30	7.28	HGL Too High!
P13	MH4	MH5	1.20	13.22	13.22	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	13.28	7.09	HGL Too High!
P15	MH5	MH20	1.60	13.14	13.14	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	13.22	7.40	HGL Too High!
P6	DI16	MH2	1.00	13.31	13.31	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.31	7.33	HGL Too High!
P9	DI3	MH3	1.00	13.30	13.30	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.30	6.62	HGL Too High!
P8	DI17	MH3	1.00	13.30	13.30	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.30	6.96	HGL Too High!
P12	DI4	MH4	1.00	13.28	13.28	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.29	6.48	HGL Too High!
P11	DI18	MH4	1.00	13.28	13.28	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.29	6.56	HGL Too High!
P14	DI5	MH5	1.00	13.22	13.22	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.22	6.61	HGL Too High!
P18	DI6	MH6	1.00	13.23	13.23	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.23	7.13	HGL Too High!
P16	MH6	MH5	1.20	13.22	13.22	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	13.23	7.55	HGL Too High!
P17	DI19	MH6	1.00	13.23	13.23	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.23	7.08	HGL Too High!
P32	DI23	MH12	1.00	14.05	14.05	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.05	4.24	HGL Too High!
P31	DI9	MH12	1.00	14.05	14.05	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.05	7.13	HGL Too High!
P30	MH12	MH11	1.60	14.04	14.04	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	14.05	7.48	HGL Too High!
P27	MH11	MH10	1.60	14.01	14.01	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	14.04	7.21	HGL Too High!
P25	MH10	MH9	1.60	14.00	14.00	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	14.01	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.98	13.98	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	14.00	7.85	HGL Too High!
P20	MH8	MH21	1.60	13.95	13.95	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	13.98	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	13.94	13.94	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	13.95	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	13.94	13.94	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	13.95	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	13.98	13.98	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	13.99	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	14.06	14.06	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	14.17	4.78	HGL Too High!
P51	STUB	DI22	1.00	14.06	14.06	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	14.08	7.16	HGL Too High!
P28	DI22	MH11	1.00	14.04	14.04	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	14.06	6.74	HGL Too High!
P29	DI8	MH11	1.00	14.04	14.04	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.04	6.92	HGL Too High!
P26	DI21	MH10	1.00	14.01	14.01	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.01	7.23	HGL Too High!
P23	DI20	MH9	1.00	14.00	14.00	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	14.00	7.38	HGL Too High!
P24	DI7	MH9	1.00	14.00	14.00	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.00	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	28.79	28.79	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.79	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	28.79	28.79	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.80	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	28.73	28.73	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	28.79	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	28.65	28.65	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	28.73	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	28.30	28.30	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	28.65	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	28.07	28.07	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	28.30	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	23.52	23.52	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	28.07	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	20.24	20.24	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	23.52	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	14.63	14.63	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	20.24	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	13.94	13.94	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	14.63	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	13.14	13.14	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	13.94	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	12.82	12.82	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	13.14	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	10.40	10.40	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	12.82	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	8.68	8.68	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	10.40	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.80**	**7.80**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**8.68**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	29.55	29.55	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	32.97	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	29.55	29.55	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.56	6.45	HGL Too High!
P3	DI14	DI13	1.00	29.55	29.55	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.55	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	28.73	28.73	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	29.55	6.58	HGL Too High!
P2	DI2	DI1	1.00	28.66	28.66	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.66	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	28.65	28.65	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	28.66	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	29.45	29.45	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.46	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	29.45	29.45	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	29.92	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	28.07	28.07	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	29.45	8.13	HGL Too High!
P42	DI31	MH22	1.00	23.93	23.93	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	23.95	5.12	HGL Too High!
P43	MH22	DI32	1.00	23.91	23.91	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	23.93	5.45	HGL Too High!
P44	DI32	EX	1.00	23.52	23.52	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	23.91	5.23	HGL Too High!
P46	DI34	DI33	1.00	23.95	23.95	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.95	5.47	HGL Too High!
P45	DI33	DI32	1.00	23.91	23.91	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	23.95	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	14.63	14.63	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.63	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	28.24	28.24	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	28.32	3.63	HGL Too High!
P48	DI40	DI41	0.80	28.24	28.24	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.25	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	28.07	28.07	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	28.24	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	13.81	13.81	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.82	7.41	
P5	MH1	MH2	1.20	13.81	13.81	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	13.81	7.93	HGL Too High!
P7	MH2	MH3	1.20	13.80	13.80	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	13.81	7.65	HGL Too High!
P10	MH3	MH4	1.20	13.78	13.78	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	13.80	7.28	HGL Too High!
P13	MH4	MH5	1.20	13.72	13.72	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	13.78	7.09	HGL Too High!
P15	MH5	MH20	1.60	13.64	13.64	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	13.72	7.40	HGL Too High!
P6	DI16	MH2	1.00	13.81	13.81	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.81	7.33	HGL Too High!
P9	DI3	MH3	1.00	13.80	13.80	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.80	6.62	HGL Too High!
P8	DI17	MH3	1.00	13.80	13.80	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.80	6.96	HGL Too High!
P12	DI4	MH4	1.00	13.78	13.78	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.79	6.48	HGL Too High!
P11	DI18	MH4	1.00	13.78	13.78	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.79	6.56	HGL Too High!
P14	DI5	MH5	1.00	13.72	13.72	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.72	6.61	HGL Too High!
P18	DI6	MH6	1.00	13.73	13.73	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.73	7.13	HGL Too High!
P16	MH6	MH5	1.20	13.72	13.72	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	13.73	7.55	HGL Too High!
P17	DI19	MH6	1.00	13.73	13.73	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.73	7.08	HGL Too High!
P32	DI23	MH12	1.00	14.55	14.55	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.55	4.24	HGL Too High!
P31	DI9	MH12	1.00	14.55	14.55	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.55	7.13	HGL Too High!
P30	MH12	MH11	1.60	14.54	14.54	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	14.55	7.48	HGL Too High!
P27	MH11	MH10	1.60	14.51	14.51	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	14.54	7.21	HGL Too High!
P25	MH10	MH9	1.60	14.50	14.50	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	14.51	7.54	HGL Too High!
P22	MH9	MH8	1.60	14.48	14.48	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	14.50	7.85	HGL Too High!
P20	MH8	MH21	1.60	14.45	14.45	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	14.48	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	14.44	14.44	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	14.45	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	14.44	14.44	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	14.45	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	14.48	14.48	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	14.49	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	14.56	14.56	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	14.67	4.78	HGL Too High!
P51	STUB	DI22	1.00	14.56	14.56	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	14.58	7.16	HGL Too High!
P28	DI22	MH11	1.00	14.54	14.54	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	14.56	6.74	HGL Too High!
P29	DI8	MH11	1.00	14.54	14.54	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.54	6.92	HGL Too High!
P26	DI21	MH10	1.00	14.51	14.51	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.51	7.23	HGL Too High!
P23	DI20	MH9	1.00	14.50	14.50	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	14.50	7.38	HGL Too High!
P24	DI7	MH9	1.00	14.50	14.50	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.50	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	29.29	29.29	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.29	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	29.29	29.29	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.30	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	29.23	29.23	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	29.29	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	29.15	29.15	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	29.23	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	28.80	28.80	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	29.15	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	28.57	28.57	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	28.80	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	24.02	24.02	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	28.57	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	20.74	20.74	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	24.02	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	15.13	15.13	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	20.74	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	14.44	14.44	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	15.13	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	13.64	13.64	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	14.44	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	13.32	13.32	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	13.64	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	10.90	10.90	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	13.32	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.18	9.18	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	10.90	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**8.30**	**8.30**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**9.18**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	30.05	30.05	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	33.47	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	30.05	30.05	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.06	6.45	HGL Too High!
P3	DI14	DI13	1.00	30.05	30.05	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.05	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	29.23	29.23	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	30.05	6.58	HGL Too High!
P2	DI2	DI1	1.00	29.16	29.16	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.16	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	29.15	29.15	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	29.16	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	29.95	29.95	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.96	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	29.95	29.95	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	30.42	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	28.57	28.57	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	29.95	8.13	HGL Too High!
P42	DI31	MH22	1.00	24.43	24.43	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	24.45	5.12	HGL Too High!
P43	MH22	DI32	1.00	24.41	24.41	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	24.43	5.45	HGL Too High!
P44	DI32	EX	1.00	24.02	24.02	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	24.41	5.23	HGL Too High!
P46	DI34	DI33	1.00	24.45	24.45	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.45	5.47	HGL Too High!
P45	DI33	DI32	1.00	24.41	24.41	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	24.45	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	15.13	15.13	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	15.13	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	28.74	28.74	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	28.82	3.63	HGL Too High!
P48	DI40	DI41	0.80	28.74	28.74	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.75	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	28.57	28.57	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	28.74	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	14.51	14.51	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.52	7.41	
P5	MH1	MH2	1.20	14.51	14.51	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	14.51	7.93	HGL Too High!
P7	MH2	MH3	1.20	14.50	14.50	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	14.51	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.48	14.48	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	14.50	7.28	HGL Too High!
P13	MH4	MH5	1.20	14.42	14.42	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	14.48	7.09	HGL Too High!
P15	MH5	MH20	1.60	14.34	14.34	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	14.42	7.40	HGL Too High!
P6	DI16	MH2	1.00	14.51	14.51	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.51	7.33	HGL Too High!
P9	DI3	MH3	1.00	14.50	14.50	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.50	6.62	HGL Too High!
P8	DI17	MH3	1.00	14.50	14.50	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.50	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.48	14.48	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.49	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.48	14.48	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.49	6.56	HGL Too High!
P14	DI5	MH5	1.00	14.42	14.42	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.42	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.43	14.43	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.43	7.13	HGL Too High!
P16	MH6	MH5	1.20	14.42	14.42	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	14.43	7.55	HGL Too High!
P17	DI19	MH6	1.00	14.43	14.43	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.43	7.08	HGL Too High!
P32	DI23	MH12	1.00	15.25	15.25	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.25	4.24	HGL Too High!
P31	DI9	MH12	1.00	15.25	15.25	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.25	7.13	HGL Too High!
P30	MH12	MH11	1.60	15.24	15.24	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	15.25	7.48	HGL Too High!
P27	MH11	MH10	1.60	15.21	15.21	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	15.24	7.21	HGL Too High!
P25	MH10	MH9	1.60	15.20	15.20	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	15.21	7.54	HGL Too High!
P22	MH9	MH8	1.60	15.18	15.18	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	15.20	7.85	HGL Too High!
P20	MH8	MH21	1.60	15.15	15.15	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	15.18	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	15.14	15.14	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	15.15	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	15.14	15.14	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	15.15	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	15.18	15.18	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	15.19	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	15.26	15.26	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	15.37	4.78	HGL Too High!
P51	STUB	DI22	1.00	15.26	15.26	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	15.28	7.16	HGL Too High!
P28	DI22	MH11	1.00	15.24	15.24	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	15.26	6.74	HGL Too High!
P29	DI8	MH11	1.00	15.24	15.24	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.24	6.92	HGL Too High!
P26	DI21	MH10	1.00	15.21	15.21	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.21	7.23	HGL Too High!
P23	DI20	MH9	1.00	15.20	15.20	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	15.20	7.38	HGL Too High!
P24	DI7	MH9	1.00	15.20	15.20	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.20	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	29.99	29.99	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.99	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	29.99	29.99	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.00	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	29.93	29.93	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	29.99	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	29.85	29.85	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	29.93	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	29.50	29.50	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	29.85	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	29.27	29.27	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	29.50	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	24.72	24.72	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	29.27	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	21.44	21.44	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	24.72	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	15.83	15.83	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	21.44	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	15.14	15.14	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	15.83	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	14.34	14.34	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	15.14	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	14.02	14.02	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	14.34	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	11.60	11.60	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	14.02	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.88	9.88	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	11.60	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.00**	**9.00**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**9.88**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	30.75	30.75	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	34.17	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	30.75	30.75	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.76	6.45	HGL Too High!
P3	DI14	DI13	1.00	30.75	30.75	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.75	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	29.93	29.93	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	30.75	6.58	HGL Too High!
P2	DI2	DI1	1.00	29.86	29.86	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.86	6.84	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	29.85	29.85	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	29.86	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	30.65	30.65	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.66	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	30.65	30.65	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	31.12	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	29.27	29.27	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	30.65	8.13	HGL Too High!
P42	DI31	MH22	1.00	25.13	25.13	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	25.15	5.12	HGL Too High!
P43	MH22	DI32	1.00	25.11	25.11	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	25.13	5.45	HGL Too High!
P44	DI32	EX	1.00	24.72	24.72	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	25.11	5.23	HGL Too High!
P46	DI34	DI33	1.00	25.15	25.15	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.15	5.47	HGL Too High!
P45	DI33	DI32	1.00	25.11	25.11	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	25.15	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	15.83	15.83	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	15.83	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	29.44	29.44	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	29.52	3.63	HGL Too High!
P48	DI40	DI41	0.80	29.44	29.44	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.45	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	29.27	29.27	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	29.44	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	15.01	15.01	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.02	7.41	
P5	MH1	MH2	1.20	15.01	15.01	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	15.01	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.00	15.00	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	15.01	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.98	14.98	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	15.00	7.28	HGL Too High!
P13	MH4	MH5	1.20	14.92	14.92	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	14.98	7.09	HGL Too High!
P15	MH5	MH20	1.60	14.84	14.84	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	14.92	7.40	HGL Too High!
P6	DI16	MH2	1.00	15.01	15.01	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.01	7.33	HGL Too High!
P9	DI3	MH3	1.00	15.00	15.00	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.00	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.00	15.00	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.00	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.98	14.98	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.99	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.98	14.98	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.99	6.56	HGL Too High!
P14	DI5	MH5	1.00	14.92	14.92	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.92	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.93	14.93	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.93	7.13	HGL Too High!
P16	MH6	MH5	1.20	14.92	14.92	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	14.93	7.55	HGL Too High!
P17	DI19	MH6	1.00	14.93	14.93	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.93	7.08	HGL Too High!
P32	DI23	MH12	1.00	15.75	15.75	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.75	4.24	HGL Too High!
P31	DI9	MH12	1.00	15.75	15.75	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.75	7.13	HGL Too High!
P30	MH12	MH11	1.60	15.74	15.74	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	15.75	7.48	HGL Too High!
P27	MH11	MH10	1.60	15.71	15.71	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	15.74	7.21	HGL Too High!
P25	MH10	MH9	1.60	15.70	15.70	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	15.71	7.54	HGL Too High!
P22	MH9	MH8	1.60	15.68	15.68	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	15.70	7.85	HGL Too High!
P20	MH8	MH21	1.60	15.65	15.65	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	15.68	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	15.64	15.64	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	15.65	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	15.64	15.64	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	15.65	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	15.68	15.68	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	15.69	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	15.76	15.76	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	15.87	4.78	HGL Too High!
P51	STUB	DI22	1.00	15.76	15.76	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	15.78	7.16	HGL Too High!
P28	DI22	MH11	1.00	15.74	15.74	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	15.76	6.74	HGL Too High!
P29	DI8	MH11	1.00	15.74	15.74	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.74	6.92	HGL Too High!
P26	DI21	MH10	1.00	15.71	15.71	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.71	7.23	HGL Too High!
P23	DI20	MH9	1.00	15.70	15.70	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	15.70	7.38	HGL Too High!
P24	DI7	MH9	1.00	15.70	15.70	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.70	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	30.49	30.49	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.49	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	30.49	30.49	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.50	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	30.43	30.43	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	30.49	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	30.35	30.35	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	30.43	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	30.00	30.00	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	30.35	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	29.77	29.77	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	30.00	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	25.22	25.22	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	29.77	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	21.94	21.94	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	25.22	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	16.33	16.33	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	21.94	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	15.64	15.64	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	16.33	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	14.84	14.84	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	15.64	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	14.52	14.52	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	14.84	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.10	12.10	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	14.52	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.38	10.38	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	12.10	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.50**	**9.50**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**10.38**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	31.25	31.25	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	34.67	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	31.25	31.25	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.26	6.45	HGL Too High!
P3	DI14	DI13	1.00	31.25	31.25	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.25	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	30.43	30.43	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	31.25	6.58	HGL Too High!
P2	DI2	DI1	1.00	30.36	30.36	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.36	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	30.35	30.35	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	30.36	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	31.15	31.15	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.16	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	31.15	31.15	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	31.62	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	29.77	29.77	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	31.15	8.13	HGL Too High!
P42	DI31	MH22	1.00	25.63	25.63	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	25.65	5.12	HGL Too High!
P43	MH22	DI32	1.00	25.61	25.61	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	25.63	5.45	HGL Too High!
P44	DI32	EX	1.00	25.22	25.22	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	25.61	5.23	HGL Too High!
P46	DI34	DI33	1.00	25.65	25.65	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.65	5.47	HGL Too High!
P45	DI33	DI32	1.00	25.61	25.61	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	25.65	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	16.33	16.33	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	16.33	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	29.94	29.94	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	30.02	3.63	HGL Too High!
P48	DI40	DI41	0.80	29.94	29.94	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.95	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	29.77	29.77	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	29.94	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	16.31	16.31	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.32	7.41	
P5	MH1	MH2	1.20	16.31	16.31	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	16.31	7.93	HGL Too High!
P7	MH2	MH3	1.20	16.30	16.30	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	16.31	7.65	HGL Too High!
P10	MH3	MH4	1.20	16.28	16.28	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	16.30	7.28	HGL Too High!
P13	MH4	MH5	1.20	16.22	16.22	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	16.28	7.09	HGL Too High!
P15	MH5	MH20	1.60	16.14	16.14	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	16.22	7.40	HGL Too High!
P6	DI16	MH2	1.00	16.31	16.31	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.31	7.33	HGL Too High!
P9	DI3	MH3	1.00	16.30	16.30	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.30	6.62	HGL Too High!
P8	DI17	MH3	1.00	16.30	16.30	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.30	6.96	HGL Too High!
P12	DI4	MH4	1.00	16.28	16.28	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.29	6.48	HGL Too High!
P11	DI18	MH4	1.00	16.28	16.28	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.29	6.56	HGL Too High!
P14	DI5	MH5	1.00	16.22	16.22	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.22	6.61	HGL Too High!
P18	DI6	MH6	1.00	16.23	16.23	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.23	7.13	HGL Too High!
P16	MH6	MH5	1.20	16.22	16.22	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	16.23	7.55	HGL Too High!
P17	DI19	MH6	1.00	16.23	16.23	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.23	7.08	HGL Too High!
P32	DI23	MH12	1.00	17.05	17.05	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.05	4.24	HGL Too High!
P31	DI9	MH12	1.00	17.05	17.05	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.05	7.13	HGL Too High!
P30	MH12	MH11	1.60	17.04	17.04	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	17.05	7.48	HGL Too High!
P27	MH11	MH10	1.60	17.01	17.01	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	17.04	7.21	HGL Too High!
P25	MH10	MH9	1.60	17.00	17.00	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	17.01	7.54	HGL Too High!
P22	MH9	MH8	1.60	16.98	16.98	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	17.00	7.85	HGL Too High!
P20	MH8	MH21	1.60	16.95	16.95	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	16.98	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	16.94	16.94	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	16.95	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	16.94	16.94	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	16.95	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	16.98	16.98	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	16.99	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	17.06	17.06	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	17.17	4.78	HGL Too High!
P51	STUB	DI22	1.00	17.06	17.06	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	17.08	7.16	HGL Too High!
P28	DI22	MH11	1.00	17.04	17.04	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	17.06	6.74	HGL Too High!
P29	DI8	MH11	1.00	17.04	17.04	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.04	6.92	HGL Too High!
P26	DI21	MH10	1.00	17.01	17.01	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.01	7.23	HGL Too High!
P23	DI20	MH9	1.00	17.00	17.00	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	17.00	7.38	HGL Too High!
P24	DI7	MH9	1.00	17.00	17.00	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.00	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	31.79	31.79	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.79	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	31.79	31.79	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.80	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	31.73	31.73	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	31.79	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	31.65	31.65	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	31.73	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	31.30	31.30	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	31.65	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	31.07	31.07	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	31.30	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	26.52	26.52	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	31.07	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	23.24	23.24	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	26.52	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	17.63	17.63	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	23.24	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	16.94	16.94	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	17.63	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	16.14	16.14	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	16.94	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	15.82	15.82	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	16.14	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.40	13.40	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	15.82	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.68	11.68	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	13.40	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.80**	**10.80**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**11.68**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	32.55	32.55	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	35.97	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	32.55	32.55	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.56	6.45	HGL Too High!
P3	DI14	DI13	1.00	32.55	32.55	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.55	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	31.73	31.73	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	32.55	6.58	HGL Too High!
P2	DI2	DI1	1.00	31.66	31.66	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.66	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	31.65	31.65	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	31.66	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	32.45	32.45	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.46	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	32.45	32.45	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	32.92	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	31.07	31.07	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	32.45	8.13	HGL Too High!
P42	DI31	MH22	1.00	26.93	26.93	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	26.95	5.12	HGL Too High!
P43	MH22	DI32	1.00	26.91	26.91	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	26.93	5.45	HGL Too High!
P44	DI32	EX	1.00	26.52	26.52	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	26.91	5.23	HGL Too High!
P46	DI34	DI33	1.00	26.95	26.95	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.95	5.47	HGL Too High!
P45	DI33	DI32	1.00	26.91	26.91	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	26.95	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	17.63	17.63	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	17.63	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	31.24	31.24	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	31.32	3.63	HGL Too High!
P48	DI40	DI41	0.80	31.24	31.24	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.25	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	31.07	31.07	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	31.24	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	11.25	11.25	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.26	7.41	
P5	MH1	MH2	1.20	11.25	11.25	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	11.25	7.93	HGL Too High!
P7	MH2	MH3	1.20	11.24	11.24	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	11.25	7.65	HGL Too High!
P10	MH3	MH4	1.20	11.22	11.22	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	11.24	7.28	HGL Too High!
P13	MH4	MH5	1.20	11.16	11.16	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	11.22	7.09	HGL Too High!
P15	MH5	MH20	1.60	11.08	11.08	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	11.16	7.40	HGL Too High!
P6	DI16	MH2	1.00	11.25	11.25	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.25	7.33	HGL Too High!
P9	DI3	MH3	1.00	11.24	11.24	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.24	6.62	HGL Too High!
P8	DI17	MH3	1.00	11.24	11.24	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.24	6.96	HGL Too High!
P12	DI4	MH4	1.00	11.22	11.22	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.23	6.48	HGL Too High!
P11	DI18	MH4	1.00	11.22	11.22	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.23	6.56	HGL Too High!
P14	DI5	MH5	1.00	11.16	11.16	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.16	6.61	HGL Too High!
P18	DI6	MH6	1.00	11.17	11.17	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.17	7.13	HGL Too High!
P16	MH6	MH5	1.20	11.16	11.16	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	11.17	7.55	HGL Too High!
P17	DI19	MH6	1.00	11.17	11.17	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.17	7.08	HGL Too High!
P32	DI23	MH12	1.00	11.99	11.99	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.99	4.24	HGL Too High!
P31	DI9	MH12	1.00	11.99	11.99	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.99	7.13	HGL Too High!
P30	MH12	MH11	1.60	11.98	11.98	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	11.99	7.48	HGL Too High!
P27	MH11	MH10	1.60	11.95	11.95	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	11.98	7.21	HGL Too High!
P25	MH10	MH9	1.60	11.94	11.94	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	11.95	7.54	HGL Too High!
P22	MH9	MH8	1.60	11.92	11.92	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	11.94	7.85	HGL Too High!
P20	MH8	MH21	1.60	11.89	11.89	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	11.92	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	11.88	11.88	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	11.89	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	11.88	11.88	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	11.89	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	11.92	11.92	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	11.93	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	12.00	12.00	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	12.11	4.78	HGL Too High!
P51	STUB	DI22	1.00	12.00	12.00	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.02	7.16	HGL Too High!
P28	DI22	MH11	1.00	11.98	11.98	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	12.00	6.74	HGL Too High!
P29	DI8	MH11	1.00	11.98	11.98	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.98	6.92	HGL Too High!
P26	DI21	MH10	1.00	11.95	11.95	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.95	7.23	HGL Too High!
P23	DI20	MH9	1.00	11.94	11.94	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	11.94	7.38	HGL Too High!
P24	DI7	MH9	1.00	11.94	11.94	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.94	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	26.73	26.73	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.73	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	26.73	26.73	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.74	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	26.67	26.67	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	26.73	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	26.59	26.59	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	26.67	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	26.24	26.24	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	26.59	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	26.01	26.01	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	26.24	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	21.46	21.46	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	26.01	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	18.18	18.18	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	21.46	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	12.57	12.57	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	18.18	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	11.88	11.88	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	12.57	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	11.08	11.08	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	11.88	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	10.76	10.76	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	11.08	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	8.34	8.34	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	10.76	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	6.62	6.62	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	8.34	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.74**	**5.74**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**6.62**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	27.49	27.49	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	30.91	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	27.49	27.49	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.50	6.45	HGL Too High!
P3	DI14	DI13	1.00	27.49	27.49	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.49	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	26.67	26.67	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	27.49	6.58	HGL Too High!
P2	DI2	DI1	1.00	26.60	26.60	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.60	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	____ of ____
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	26.59	26.59	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	26.60	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	27.39	27.39	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.40	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	27.39	27.39	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	27.86	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	26.01	26.01	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	27.39	8.13	HGL Too High!
P42	DI31	MH22	1.00	21.87	21.87	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	21.89	5.12	HGL Too High!
P43	MH22	DI32	1.00	21.85	21.85	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	21.87	5.45	HGL Too High!
P44	DI32	EX	1.00	21.46	21.46	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	21.85	5.23	HGL Too High!
P46	DI34	DI33	1.00	21.89	21.89	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.89	5.47	HGL Too High!
P45	DI33	DI32	1.00	21.85	21.85	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	21.89	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	12.57	12.57	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	12.57	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	26.18	26.18	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	26.26	3.63	HGL Too High!
P48	DI40	DI41	0.80	26.18	26.18	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.19	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	26.01	26.01	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	26.18	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	11.45	11.45	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.46	7.41	
P5	MH1	MH2	1.20	11.45	11.45	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	11.45	7.93	HGL Too High!
P7	MH2	MH3	1.20	11.44	11.44	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	11.45	7.65	HGL Too High!
P10	MH3	MH4	1.20	11.42	11.42	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	11.44	7.28	HGL Too High!
P13	MH4	MH5	1.20	11.36	11.36	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	11.42	7.09	HGL Too High!
P15	MH5	MH20	1.60	11.28	11.28	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	11.36	7.40	HGL Too High!
P6	DI16	MH2	1.00	11.45	11.45	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.45	7.33	HGL Too High!
P9	DI3	MH3	1.00	11.44	11.44	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.44	6.62	HGL Too High!
P8	DI17	MH3	1.00	11.44	11.44	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.44	6.96	HGL Too High!
P12	DI4	MH4	1.00	11.42	11.42	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.43	6.48	HGL Too High!
P11	DI18	MH4	1.00	11.42	11.42	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.43	6.56	HGL Too High!
P14	DI5	MH5	1.00	11.36	11.36	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.36	6.61	HGL Too High!
P18	DI6	MH6	1.00	11.37	11.37	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	11.37	7.13	HGL Too High!
P16	MH6	MH5	1.20	11.36	11.36	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	11.37	7.55	HGL Too High!
P17	DI19	MH6	1.00	11.37	11.37	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	11.37	7.08	HGL Too High!
P32	DI23	MH12	1.00	12.19	12.19	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.19	4.24	HGL Too High!
P31	DI9	MH12	1.00	12.19	12.19	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.19	7.13	HGL Too High!
P30	MH12	MH11	1.60	12.18	12.18	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	12.19	7.48	HGL Too High!
P27	MH11	MH10	1.60	12.15	12.15	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	12.18	7.21	HGL Too High!
P25	MH10	MH9	1.60	12.14	12.14	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	12.15	7.54	HGL Too High!
P22	MH9	MH8	1.60	12.12	12.12	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	12.14	7.85	HGL Too High!
P20	MH8	MH21	1.60	12.09	12.09	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	12.12	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	12.08	12.08	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	12.09	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	12.08	12.08	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	12.09	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	12.12	12.12	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	12.13	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	12.20	12.20	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	12.31	4.78	HGL Too High!
P51	STUB	DI22	1.00	12.20	12.20	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	12.22	7.16	HGL Too High!
P28	DI22	MH11	1.00	12.18	12.18	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	12.20	6.74	HGL Too High!
P29	DI8	MH11	1.00	12.18	12.18	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.18	6.92	HGL Too High!
P26	DI21	MH10	1.00	12.15	12.15	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.15	7.23	HGL Too High!
P23	DI20	MH9	1.00	12.14	12.14	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	12.14	7.38	HGL Too High!
P24	DI7	MH9	1.00	12.14	12.14	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.14	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	26.93	26.93	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.93	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	26.93	26.93	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.94	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	26.87	26.87	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	26.93	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	26.79	26.79	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	26.87	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	26.44	26.44	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	26.79	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	26.21	26.21	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	26.44	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	21.66	21.66	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	26.21	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	18.38	18.38	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	21.66	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	12.77	12.77	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	18.38	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	12.08	12.08	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	12.77	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	11.28	11.28	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	12.08	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	10.96	10.96	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	11.28	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	8.54	8.54	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	10.96	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	6.82	6.82	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	8.54	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.94**	**5.94**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**6.82**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	27.69	27.69	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	31.11	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	27.69	27.69	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.70	6.45	HGL Too High!
P3	DI14	DI13	1.00	27.69	27.69	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.69	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	26.87	26.87	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	27.69	6.58	HGL Too High!
P2	DI2	DI1	1.00	26.80	26.80	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.80	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	26.79	26.79	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	26.80	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	27.59	27.59	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.60	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	27.59	27.59	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	28.06	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	26.21	26.21	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	27.59	8.13	HGL Too High!
P42	DI31	MH22	1.00	22.07	22.07	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	22.09	5.12	HGL Too High!
P43	MH22	DI32	1.00	22.05	22.05	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	22.07	5.45	HGL Too High!
P44	DI32	EX	1.00	21.66	21.66	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	22.05	5.23	HGL Too High!
P46	DI34	DI33	1.00	22.09	22.09	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.09	5.47	HGL Too High!
P45	DI33	DI32	1.00	22.05	22.05	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	22.09	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	12.77	12.77	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	12.77	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	26.38	26.38	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	26.46	3.63	HGL Too High!
P48	DI40	DI41	0.80	26.38	26.38	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.39	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	26.21	26.21	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	26.38	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	14.95	14.95	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.96	7.41	
P5	MH1	MH2	1.20	14.95	14.95	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	14.95	7.93	HGL Too High!
P7	MH2	MH3	1.20	14.94	14.94	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	14.95	7.65	HGL Too High!
P10	MH3	MH4	1.20	14.92	14.92	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	14.94	7.28	HGL Too High!
P13	MH4	MH5	1.20	14.86	14.86	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	14.92	7.09	HGL Too High!
P15	MH5	MH20	1.60	14.78	14.78	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	14.86	7.40	HGL Too High!
P6	DI16	MH2	1.00	14.95	14.95	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.95	7.33	HGL Too High!
P9	DI3	MH3	1.00	14.94	14.94	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.94	6.62	HGL Too High!
P8	DI17	MH3	1.00	14.94	14.94	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.94	6.96	HGL Too High!
P12	DI4	MH4	1.00	14.92	14.92	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.93	6.48	HGL Too High!
P11	DI18	MH4	1.00	14.92	14.92	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.93	6.56	HGL Too High!
P14	DI5	MH5	1.00	14.86	14.86	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.86	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.87	14.87	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.87	7.13	HGL Too High!
P16	MH6	MH5	1.20	14.86	14.86	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	14.87	7.55	HGL Too High!
P17	DI19	MH6	1.00	14.87	14.87	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.87	7.08	HGL Too High!
P32	DI23	MH12	1.00	15.69	15.69	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.69	4.24	HGL Too High!
P31	DI9	MH12	1.00	15.69	15.69	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.69	7.13	HGL Too High!
P30	MH12	MH11	1.60	15.68	15.68	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	15.69	7.48	HGL Too High!
P27	MH11	MH10	1.60	15.65	15.65	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	15.68	7.21	HGL Too High!
P25	MH10	MH9	1.60	15.64	15.64	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	15.65	7.54	HGL Too High!
P22	MH9	MH8	1.60	15.62	15.62	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	15.64	7.85	HGL Too High!
P20	MH8	MH21	1.60	15.59	15.59	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	15.62	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	15.58	15.58	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	15.59	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	15.58	15.58	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	15.59	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	15.62	15.62	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	15.63	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	15.70	15.70	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	15.81	4.78	HGL Too High!
P51	STUB	DI22	1.00	15.70	15.70	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	15.72	7.16	HGL Too High!
P28	DI22	MH11	1.00	15.68	15.68	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	15.70	6.74	HGL Too High!
P29	DI8	MH11	1.00	15.68	15.68	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.68	6.92	HGL Too High!
P26	DI21	MH10	1.00	15.65	15.65	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.65	7.23	HGL Too High!
P23	DI20	MH9	1.00	15.64	15.64	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	15.64	7.38	HGL Too High!
P24	DI7	MH9	1.00	15.64	15.64	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.64	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	30.43	30.43	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.43	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	30.43	30.43	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.44	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	30.37	30.37	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	30.43	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	30.29	30.29	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	30.37	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	29.94	29.94	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	30.29	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	29.71	29.71	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	29.94	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	25.16	25.16	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	29.71	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	21.88	21.88	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	25.16	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	16.27	16.27	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	21.88	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	15.58	15.58	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	16.27	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	14.78	14.78	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	15.58	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	14.46	14.46	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	14.78	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.04	12.04	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	14.46	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.32	10.32	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	12.04	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.44**	**9.44**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**10.32**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	31.19	31.19	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	34.61	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	31.19	31.19	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.20	6.45	HGL Too High!
P3	DI14	DI13	1.00	31.19	31.19	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.19	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	30.37	30.37	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	31.19	6.58	HGL Too High!
P2	DI2	DI1	1.00	30.30	30.30	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.30	6.84	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	30.29	30.29	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	30.30	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	31.09	31.09	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.10	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	31.09	31.09	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	31.56	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	29.71	29.71	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	31.09	8.13	HGL Too High!
P42	DI31	MH22	1.00	25.57	25.57	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	25.59	5.12	HGL Too High!
P43	MH22	DI32	1.00	25.55	25.55	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	25.57	5.45	HGL Too High!
P44	DI32	EX	1.00	25.16	25.16	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	25.55	5.23	HGL Too High!
P46	DI34	DI33	1.00	25.59	25.59	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.59	5.47	HGL Too High!
P45	DI33	DI32	1.00	25.55	25.55	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	25.59	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	16.27	16.27	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	16.27	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	29.88	29.88	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	29.96	3.63	HGL Too High!
P48	DI40	DI41	0.80	29.88	29.88	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.89	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	29.71	29.71	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	29.88	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	15.45	15.45	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.46	7.41	
P5	MH1	MH2	1.20	15.45	15.45	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	15.45	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.44	15.44	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	15.45	7.65	HGL Too High!
P10	MH3	MH4	1.20	15.42	15.42	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	15.44	7.28	HGL Too High!
P13	MH4	MH5	1.20	15.36	15.36	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	15.42	7.09	HGL Too High!
P15	MH5	MH20	1.60	15.28	15.28	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	15.36	7.40	HGL Too High!
P6	DI16	MH2	1.00	15.45	15.45	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.45	7.33	HGL Too High!
P9	DI3	MH3	1.00	15.44	15.44	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.44	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.44	15.44	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.44	6.96	HGL Too High!
P12	DI4	MH4	1.00	15.42	15.42	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.43	6.48	HGL Too High!
P11	DI18	MH4	1.00	15.42	15.42	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.43	6.56	HGL Too High!
P14	DI5	MH5	1.00	15.36	15.36	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.36	6.61	HGL Too High!
P18	DI6	MH6	1.00	15.37	15.37	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.37	7.13	HGL Too High!
P16	MH6	MH5	1.20	15.36	15.36	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	15.37	7.55	HGL Too High!
P17	DI19	MH6	1.00	15.37	15.37	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.37	7.08	HGL Too High!
P32	DI23	MH12	1.00	16.19	16.19	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.19	4.24	HGL Too High!
P31	DI9	MH12	1.00	16.19	16.19	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.19	7.13	HGL Too High!
P30	MH12	MH11	1.60	16.18	16.18	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	16.19	7.48	HGL Too High!
P27	MH11	MH10	1.60	16.15	16.15	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	16.18	7.21	HGL Too High!
P25	MH10	MH9	1.60	16.14	16.14	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	16.15	7.54	HGL Too High!
P22	MH9	MH8	1.60	16.12	16.12	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	16.14	7.85	HGL Too High!
P20	MH8	MH21	1.60	16.09	16.09	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	16.12	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	16.08	16.08	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	16.09	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	16.08	16.08	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	16.09	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	16.12	16.12	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	16.13	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	16.20	16.20	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	16.31	4.78	HGL Too High!
P51	STUB	DI22	1.00	16.20	16.20	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	16.22	7.16	HGL Too High!
P28	DI22	MH11	1.00	16.18	16.18	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	16.20	6.74	HGL Too High!
P29	DI8	MH11	1.00	16.18	16.18	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.18	6.92	HGL Too High!
P26	DI21	MH10	1.00	16.15	16.15	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.15	7.23	HGL Too High!
P23	DI20	MH9	1.00	16.14	16.14	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	16.14	7.38	HGL Too High!
P24	DI7	MH9	1.00	16.14	16.14	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.14	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	30.93	30.93	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.93	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	30.93	30.93	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.94	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	30.87	30.87	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	30.93	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	30.79	30.79	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	30.87	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	30.44	30.44	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	30.79	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	30.21	30.21	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	30.44	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	25.66	25.66	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	30.21	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	22.38	22.38	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	25.66	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	16.77	16.77	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	22.38	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	16.08	16.08	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	16.77	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	15.28	15.28	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	16.08	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	14.96	14.96	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	15.28	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.54	12.54	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	14.96	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.82	10.82	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	12.54	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.94**	**9.94**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**10.82**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	31.69	31.69	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	35.11	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	31.69	31.69	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.70	6.45	HGL Too High!
P3	DI14	DI13	1.00	31.69	31.69	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.69	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	30.87	30.87	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	31.69	6.58	HGL Too High!
P2	DI2	DI1	1.00	30.80	30.80	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.80	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	30.79	30.79	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	30.80	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	31.59	31.59	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.60	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	31.59	31.59	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	32.06	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	30.21	30.21	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	31.59	8.13	HGL Too High!
P42	DI31	MH22	1.00	26.07	26.07	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	26.09	5.12	HGL Too High!
P43	MH22	DI32	1.00	26.05	26.05	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	26.07	5.45	HGL Too High!
P44	DI32	EX	1.00	25.66	25.66	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	26.05	5.23	HGL Too High!
P46	DI34	DI33	1.00	26.09	26.09	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.09	5.47	HGL Too High!
P45	DI33	DI32	1.00	26.05	26.05	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	26.09	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	16.77	16.77	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	16.77	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	30.38	30.38	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	30.46	3.63	HGL Too High!
P48	DI40	DI41	0.80	30.38	30.38	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.39	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	30.21	30.21	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	30.38	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	15.85	15.85	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.86	7.41	
P5	MH1	MH2	1.20	15.85	15.85	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	15.85	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.84	15.84	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	15.85	7.65	HGL Too High!
P10	MH3	MH4	1.20	15.82	15.82	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	15.84	7.28	HGL Too High!
P13	MH4	MH5	1.20	15.76	15.76	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	15.82	7.09	HGL Too High!
P15	MH5	MH20	1.60	15.68	15.68	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	15.76	7.40	HGL Too High!
P6	DI16	MH2	1.00	15.85	15.85	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.85	7.33	HGL Too High!
P9	DI3	MH3	1.00	15.84	15.84	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.84	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.84	15.84	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.84	6.96	HGL Too High!
P12	DI4	MH4	1.00	15.82	15.82	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.83	6.48	HGL Too High!
P11	DI18	MH4	1.00	15.82	15.82	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.83	6.56	HGL Too High!
P14	DI5	MH5	1.00	15.76	15.76	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.76	6.61	HGL Too High!
P18	DI6	MH6	1.00	15.77	15.77	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.77	7.13	HGL Too High!
P16	MH6	MH5	1.20	15.76	15.76	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	15.77	7.55	HGL Too High!
P17	DI19	MH6	1.00	15.77	15.77	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.77	7.08	HGL Too High!
P32	DI23	MH12	1.00	16.59	16.59	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.59	4.24	HGL Too High!
P31	DI9	MH12	1.00	16.59	16.59	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.59	7.13	HGL Too High!
P30	MH12	MH11	1.60	16.58	16.58	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	16.59	7.48	HGL Too High!
P27	MH11	MH10	1.60	16.55	16.55	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	16.58	7.21	HGL Too High!
P25	MH10	MH9	1.60	16.54	16.54	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	16.55	7.54	HGL Too High!
P22	MH9	MH8	1.60	16.52	16.52	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	16.54	7.85	HGL Too High!
P20	MH8	MH21	1.60	16.49	16.49	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	16.52	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	16.48	16.48	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	16.49	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	16.48	16.48	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	16.49	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	16.52	16.52	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	16.53	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	16.60	16.60	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	16.71	4.78	HGL Too High!
P51	STUB	DI22	1.00	16.60	16.60	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	16.62	7.16	HGL Too High!
P28	DI22	MH11	1.00	16.58	16.58	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	16.60	6.74	HGL Too High!
P29	DI8	MH11	1.00	16.58	16.58	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.58	6.92	HGL Too High!
P26	DI21	MH10	1.00	16.55	16.55	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.55	7.23	HGL Too High!
P23	DI20	MH9	1.00	16.54	16.54	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	16.54	7.38	HGL Too High!
P24	DI7	MH9	1.00	16.54	16.54	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.54	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	31.33	31.33	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.33	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	31.33	31.33	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.34	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	31.27	31.27	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	31.33	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	31.19	31.19	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	31.27	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	30.84	30.84	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	31.19	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	30.61	30.61	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	30.84	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	26.06	26.06	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	30.61	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	22.78	22.78	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	26.06	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	17.17	17.17	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	22.78	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	16.48	16.48	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	17.17	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	15.68	15.68	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	16.48	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	15.36	15.36	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	15.68	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.94	12.94	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	15.36	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.22	11.22	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	12.94	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.34**	**10.34**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**11.22**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	32.09	32.09	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	35.51	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	32.09	32.09	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.10	6.45	HGL Too High!
P3	DI14	DI13	1.00	32.09	32.09	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.09	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	31.27	31.27	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	32.09	6.58	HGL Too High!
P2	DI2	DI1	1.00	31.20	31.20	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.20	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	31.19	31.19	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	31.20	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	31.99	31.99	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.00	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	31.99	31.99	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	32.46	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	30.61	30.61	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	31.99	8.13	HGL Too High!
P42	DI31	MH22	1.00	26.47	26.47	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	26.49	5.12	HGL Too High!
P43	MH22	DI32	1.00	26.45	26.45	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	26.47	5.45	HGL Too High!
P44	DI32	EX	1.00	26.06	26.06	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	26.45	5.23	HGL Too High!
P46	DI34	DI33	1.00	26.49	26.49	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.49	5.47	HGL Too High!
P45	DI33	DI32	1.00	26.45	26.45	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	26.49	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	17.17	17.17	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	17.17	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	30.78	30.78	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	30.86	3.63	HGL Too High!
P48	DI40	DI41	0.80	30.78	30.78	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.79	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	30.61	30.61	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	30.78	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	16.35	16.35	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.36	7.41	
P5	MH1	MH2	1.20	16.35	16.35	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	16.35	7.93	HGL Too High!
P7	MH2	MH3	1.20	16.34	16.34	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	16.35	7.65	HGL Too High!
P10	MH3	MH4	1.20	16.32	16.32	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	16.34	7.28	HGL Too High!
P13	MH4	MH5	1.20	16.26	16.26	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	16.32	7.09	HGL Too High!
P15	MH5	MH20	1.60	16.18	16.18	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	16.26	7.40	HGL Too High!
P6	DI16	MH2	1.00	16.35	16.35	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.35	7.33	HGL Too High!
P9	DI3	MH3	1.00	16.34	16.34	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.34	6.62	HGL Too High!
P8	DI17	MH3	1.00	16.34	16.34	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.34	6.96	HGL Too High!
P12	DI4	MH4	1.00	16.32	16.32	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.33	6.48	HGL Too High!
P11	DI18	MH4	1.00	16.32	16.32	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.33	6.56	HGL Too High!
P14	DI5	MH5	1.00	16.26	16.26	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.26	6.61	HGL Too High!
P18	DI6	MH6	1.00	16.27	16.27	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.27	7.13	HGL Too High!
P16	MH6	MH5	1.20	16.26	16.26	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	16.27	7.55	HGL Too High!
P17	DI19	MH6	1.00	16.27	16.27	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.27	7.08	HGL Too High!
P32	DI23	MH12	1.00	17.09	17.09	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.09	4.24	HGL Too High!
P31	DI9	MH12	1.00	17.09	17.09	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.09	7.13	HGL Too High!
P30	MH12	MH11	1.60	17.08	17.08	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	17.09	7.48	HGL Too High!
P27	MH11	MH10	1.60	17.05	17.05	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	17.08	7.21	HGL Too High!
P25	MH10	MH9	1.60	17.04	17.04	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	17.05	7.54	HGL Too High!
P22	MH9	MH8	1.60	17.02	17.02	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	17.04	7.85	HGL Too High!
P20	MH8	MH21	1.60	16.99	16.99	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	17.02	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	16.98	16.98	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	16.99	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	16.98	16.98	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	16.99	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	17.02	17.02	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	17.03	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	17.10	17.10	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	17.21	4.78	HGL Too High!
P51	STUB	DI22	1.00	17.10	17.10	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	17.12	7.16	HGL Too High!
P28	DI22	MH11	1.00	17.08	17.08	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	17.10	6.74	HGL Too High!
P29	DI8	MH11	1.00	17.08	17.08	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.08	6.92	HGL Too High!
P26	DI21	MH10	1.00	17.05	17.05	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.05	7.23	HGL Too High!
P23	DI20	MH9	1.00	17.04	17.04	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	17.04	7.38	HGL Too High!
P24	DI7	MH9	1.00	17.04	17.04	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.04	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	31.83	31.83	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.83	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	31.83	31.83	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.84	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	31.77	31.77	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	31.83	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	31.69	31.69	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	31.77	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	31.34	31.34	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	31.69	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	31.11	31.11	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	31.34	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	26.56	26.56	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	31.11	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	23.28	23.28	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	26.56	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	17.67	17.67	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	23.28	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	16.98	16.98	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	17.67	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	16.18	16.18	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	16.98	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	15.86	15.86	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	16.18	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.44	13.44	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	15.86	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.72	11.72	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	13.44	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.84**	**10.84**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**11.72**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	32.59	32.59	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	36.01	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	32.59	32.59	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.60	6.45	HGL Too High!
P3	DI14	DI13	1.00	32.59	32.59	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.59	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	31.77	31.77	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	32.59	6.58	HGL Too High!
P2	DI2	DI1	1.00	31.70	31.70	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.70	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	31.69	31.69	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	31.70	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	32.49	32.49	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.50	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	32.49	32.49	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	32.96	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	31.11	31.11	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	32.49	8.13	HGL Too High!
P42	DI31	MH22	1.00	26.97	26.97	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	26.99	5.12	HGL Too High!
P43	MH22	DI32	1.00	26.95	26.95	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	26.97	5.45	HGL Too High!
P44	DI32	EX	1.00	26.56	26.56	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	26.95	5.23	HGL Too High!
P46	DI34	DI33	1.00	26.99	26.99	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.99	5.47	HGL Too High!
P45	DI33	DI32	1.00	26.95	26.95	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	26.99	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	17.67	17.67	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	17.67	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	31.28	31.28	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	31.36	3.63	HGL Too High!
P48	DI40	DI41	0.80	31.28	31.28	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.29	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	31.11	31.11	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	31.28	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	17.05	17.05	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.06	7.41	
P5	MH1	MH2	1.20	17.05	17.05	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	17.05	7.93	HGL Too High!
P7	MH2	MH3	1.20	17.04	17.04	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	17.05	7.65	HGL Too High!
P10	MH3	MH4	1.20	17.02	17.02	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	17.04	7.28	HGL Too High!
P13	MH4	MH5	1.20	16.96	16.96	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	17.02	7.09	HGL Too High!
P15	MH5	MH20	1.60	16.88	16.88	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	16.96	7.40	HGL Too High!
P6	DI16	MH2	1.00	17.05	17.05	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.05	7.33	HGL Too High!
P9	DI3	MH3	1.00	17.04	17.04	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.04	6.62	HGL Too High!
P8	DI17	MH3	1.00	17.04	17.04	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.04	6.96	HGL Too High!
P12	DI4	MH4	1.00	17.02	17.02	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.03	6.48	HGL Too High!
P11	DI18	MH4	1.00	17.02	17.02	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.03	6.56	HGL Too High!
P14	DI5	MH5	1.00	16.96	16.96	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.96	6.61	HGL Too High!
P18	DI6	MH6	1.00	16.97	16.97	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.97	7.13	HGL Too High!
P16	MH6	MH5	1.20	16.96	16.96	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	16.97	7.55	HGL Too High!
P17	DI19	MH6	1.00	16.97	16.97	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.97	7.08	HGL Too High!
P32	DI23	MH12	1.00	17.79	17.79	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.79	4.24	HGL Too High!
P31	DI9	MH12	1.00	17.79	17.79	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.79	7.13	HGL Too High!
P30	MH12	MH11	1.60	17.78	17.78	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	17.79	7.48	HGL Too High!
P27	MH11	MH10	1.60	17.75	17.75	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	17.78	7.21	HGL Too High!
P25	MH10	MH9	1.60	17.74	17.74	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	17.75	7.54	HGL Too High!
P22	MH9	MH8	1.60	17.72	17.72	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	17.74	7.85	HGL Too High!
P20	MH8	MH21	1.60	17.69	17.69	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	17.72	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	17.68	17.68	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	17.69	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	17.68	17.68	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	17.69	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	17.72	17.72	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	17.73	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	17.80	17.80	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	17.91	4.78	HGL Too High!
P51	STUB	DI22	1.00	17.80	17.80	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	17.82	7.16	HGL Too High!
P28	DI22	MH11	1.00	17.78	17.78	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	17.80	6.74	HGL Too High!
P29	DI8	MH11	1.00	17.78	17.78	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.78	6.92	HGL Too High!
P26	DI21	MH10	1.00	17.75	17.75	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.75	7.23	HGL Too High!
P23	DI20	MH9	1.00	17.74	17.74	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	17.74	7.38	HGL Too High!
P24	DI7	MH9	1.00	17.74	17.74	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.74	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	32.53	32.53	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.53	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	32.53	32.53	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.54	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	32.47	32.47	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	32.53	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	32.39	32.39	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	32.47	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	32.04	32.04	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	32.39	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	31.81	31.81	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	32.04	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	27.26	27.26	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	31.81	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	23.98	23.98	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	27.26	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	18.37	18.37	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	23.98	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	17.68	17.68	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	18.37	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	16.88	16.88	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	17.68	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	16.56	16.56	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	16.88	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	14.14	14.14	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	16.56	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.42	12.42	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	14.14	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**11.54**	**11.54**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**12.42**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	33.29	33.29	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	36.71	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	33.29	33.29	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.30	6.45	HGL Too High!
P3	DI14	DI13	1.00	33.29	33.29	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.29	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	32.47	32.47	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	33.29	6.58	HGL Too High!
P2	DI2	DI1	1.00	32.40	32.40	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.40	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	32.39	32.39	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	32.40	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	33.19	33.19	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.20	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	33.19	33.19	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	33.66	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	31.81	31.81	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	33.19	8.13	HGL Too High!
P42	DI31	MH22	1.00	27.67	27.67	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	27.69	5.12	HGL Too High!
P43	MH22	DI32	1.00	27.65	27.65	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	27.67	5.45	HGL Too High!
P44	DI32	EX	1.00	27.26	27.26	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	27.65	5.23	HGL Too High!
P46	DI34	DI33	1.00	27.69	27.69	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.69	5.47	HGL Too High!
P45	DI33	DI32	1.00	27.65	27.65	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	27.69	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	18.37	18.37	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	18.37	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	31.98	31.98	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	32.06	3.63	HGL Too High!
P48	DI40	DI41	0.80	31.98	31.98	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.99	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	31.81	31.81	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	31.98	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	17.55	17.55	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.56	7.41	
P5	MH1	MH2	1.20	17.55	17.55	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	17.55	7.93	HGL Too High!
P7	MH2	MH3	1.20	17.54	17.54	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	17.55	7.65	HGL Too High!
P10	MH3	MH4	1.20	17.52	17.52	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	17.54	7.28	HGL Too High!
P13	MH4	MH5	1.20	17.46	17.46	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	17.52	7.09	HGL Too High!
P15	MH5	MH20	1.60	17.38	17.38	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	17.46	7.40	HGL Too High!
P6	DI16	MH2	1.00	17.55	17.55	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.55	7.33	HGL Too High!
P9	DI3	MH3	1.00	17.54	17.54	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.54	6.62	HGL Too High!
P8	DI17	MH3	1.00	17.54	17.54	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.54	6.96	HGL Too High!
P12	DI4	MH4	1.00	17.52	17.52	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.53	6.48	HGL Too High!
P11	DI18	MH4	1.00	17.52	17.52	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.53	6.56	HGL Too High!
P14	DI5	MH5	1.00	17.46	17.46	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.46	6.61	HGL Too High!
P18	DI6	MH6	1.00	17.47	17.47	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.47	7.13	HGL Too High!
P16	MH6	MH5	1.20	17.46	17.46	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	17.47	7.55	HGL Too High!
P17	DI19	MH6	1.00	17.47	17.47	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.47	7.08	HGL Too High!
P32	DI23	MH12	1.00	18.29	18.29	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.29	4.24	HGL Too High!
P31	DI9	MH12	1.00	18.29	18.29	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.29	7.13	HGL Too High!
P30	MH12	MH11	1.60	18.28	18.28	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	18.29	7.48	HGL Too High!
P27	MH11	MH10	1.60	18.25	18.25	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	18.28	7.21	HGL Too High!
P25	MH10	MH9	1.60	18.24	18.24	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	18.25	7.54	HGL Too High!
P22	MH9	MH8	1.60	18.22	18.22	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	18.24	7.85	HGL Too High!
P20	MH8	MH21	1.60	18.19	18.19	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	18.22	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	18.18	18.18	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	18.19	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	18.18	18.18	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	18.19	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	18.22	18.22	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	18.23	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	18.30	18.30	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	18.41	4.78	HGL Too High!
P51	STUB	DI22	1.00	18.30	18.30	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	18.32	7.16	HGL Too High!
P28	DI22	MH11	1.00	18.28	18.28	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	18.30	6.74	HGL Too High!
P29	DI8	MH11	1.00	18.28	18.28	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.28	6.92	HGL Too High!
P26	DI21	MH10	1.00	18.25	18.25	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.25	7.23	HGL Too High!
P23	DI20	MH9	1.00	18.24	18.24	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	18.24	7.38	HGL Too High!
P24	DI7	MH9	1.00	18.24	18.24	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.24	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	33.03	33.03	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.03	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	33.03	33.03	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.04	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	32.97	32.97	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	33.03	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	32.89	32.89	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	32.97	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	32.54	32.54	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	32.89	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	32.31	32.31	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	32.54	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	27.76	27.76	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	32.31	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	24.48	24.48	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	27.76	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	18.87	18.87	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	24.48	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	18.18	18.18	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	18.87	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	17.38	17.38	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	18.18	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	17.06	17.06	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	17.38	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	14.64	14.64	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	17.06	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.92	12.92	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	14.64	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**12.04**	**12.04**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**12.92**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	33.79	33.79	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	37.21	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	33.79	33.79	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.80	6.45	HGL Too High!
P3	DI14	DI13	1.00	33.79	33.79	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.79	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	32.97	32.97	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	33.79	6.58	HGL Too High!
P2	DI2	DI1	1.00	32.90	32.90	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.90	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	32.89	32.89	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	32.90	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	33.69	33.69	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.70	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	33.69	33.69	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	34.16	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	32.31	32.31	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	33.69	8.13	HGL Too High!
P42	DI31	MH22	1.00	28.17	28.17	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	28.19	5.12	HGL Too High!
P43	MH22	DI32	1.00	28.15	28.15	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	28.17	5.45	HGL Too High!
P44	DI32	EX	1.00	27.76	27.76	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	28.15	5.23	HGL Too High!
P46	DI34	DI33	1.00	28.19	28.19	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.19	5.47	HGL Too High!
P45	DI33	DI32	1.00	28.15	28.15	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	28.19	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	18.87	18.87	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	18.87	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	32.48	32.48	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	32.56	3.63	HGL Too High!
P48	DI40	DI41	0.80	32.48	32.48	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.49	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	32.31	32.31	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	32.48	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	18.85	18.85	15	0.4	0.3	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.86	7.41	
P5	MH1	MH2	1.20	18.85	18.85	18	0.7	0.4	0	82.7	0.0000	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	90	0.00	0.00	1.3	0.5	0.00	0.00	18.85	7.93	HGL Too High!
P7	MH2	MH3	1.20	18.84	18.84	18	1.1	0.6	1	73.8	0.0001	0.01	0	0.00	0.00	0.3	0.1	0.0	0.4	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	18.85	7.65	HGL Too High!
P10	MH3	MH4	1.20	18.82	18.82	18	2.0	1.1	8	53.7	0.0003	0.02	0	0.00	0.00	0.7	0.2	0.2	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.02	18.84	7.28	HGL Too High!
P13	MH4	MH5	1.20	18.76	18.76	18	3.4	1.9	84	59.3	0.0009	0.05	0	0.00	0.01	2.2	1.0	0.8	1.1	0.0	8	0.00	0.02	1.0	0.5	0.01	0.06	18.82	7.09	HGL Too High!
P15	MH5	MH20	1.60	18.68	18.68	24	5.0	1.6	90	104	0.0004	0.04	0	0.00	0.01	6.4	0.9	0.3	1.9	0.0	84	0.04	0.07	1.0	0.5	0.03	0.08	18.76	7.40	HGL Too High!
P6	DI16	MH2	1.00	18.85	18.85	15	0.4	0.3	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.85	7.33	HGL Too High!
P9	DI3	MH3	1.00	18.84	18.84	15	0.5	0.4	87	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.84	6.62	HGL Too High!
P8	DI17	MH3	1.00	18.84	18.84	15	0.4	0.4	81	31.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.84	6.96	HGL Too High!
P12	DI4	MH4	1.00	18.82	18.82	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.83	6.48	HGL Too High!
P11	DI18	MH4	1.00	18.82	18.82	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.83	6.56	HGL Too High!
P14	DI5	MH5	1.00	18.76	18.76	15	0.6	0.5	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.76	6.61	HGL Too High!
P18	DI6	MH6	1.00	18.77	18.77	15	0.8	0.6	23	38	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.77	7.13	HGL Too High!
P16	MH6	MH5	1.20	18.76	18.76	18	1.3	0.7	86	40	0.0001	0.00	0	0.00	0.00	0.5	0.2	0.0	0.6	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	18.77	7.55	HGL Too High!
P17	DI19	MH6	1.00	18.77	18.77	15	0.5	0.4	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.77	7.08	HGL Too High!
P32	DI23	MH12	1.00	19.59	19.59	15	0.6	0.5	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.59	4.24	HGL Too High!
P31	DI9	MH12	1.00	19.59	19.59	15	0.5	0.4	90	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.59	7.13	HGL Too High!
P30	MH12	MH11	1.60	19.58	19.58	24	1.1	0.3	1	50.1	0.0001	0.00	0	0.00	0.00	0.2	0.3	0.0	0.5	0.0	64	0.00	0.00	1.0	0.5	0.00	0.01	19.59	7.48	HGL Too High!
P27	MH11	MH10	1.60	19.55	19.55	24	2.2	0.7	5	73.2	0.0004	0.03	0	0.00	0.00	0.4	0.3	0.2	0.3	0.0	1	0.00	0.00	1.0	0.5	0.00	0.03	19.58	7.21	HGL Too High!
P25	MH10	MH9	1.60	19.54	19.54	24	2.5	0.8	5	69.7	0.0001	0.01	0	0.00	0.00	1.5	0.1	0.0	0.7	0.0	5	0.00	0.01	1.0	0.5	0.00	0.01	19.55	7.54	HGL Too High!
P22	MH9	MH8	1.60	19.52	19.52	24	3.1	1.0	51	108	0.0002	0.02	0	0.00	0.00	1.9	0.1	0.1	0.8	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	19.54	7.85	HGL Too High!
P20	MH8	MH21	1.60	19.49	19.49	24	4.0	1.3	90	57.3	0.0003	0.02	0	0.00	0.01	3.1	0.9	0.0	1.0	0.0	51	0.01	0.02	1.0	0.5	0.01	0.02	19.52	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	19.48	19.48	24	4.0	1.3	21	11.3	0.0003	0.00	0	0.00	0.01	5.1	0.0	0.0	1.3	0.0	90	0.02	0.03	1.0	0.5	0.02	0.02	19.49	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	19.48	19.48	18	3.1	1.8	35	7.75	0.0008	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.02	19.49	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	19.52	19.52	15	1.0	0.8	35	49	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.01	19.53	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	19.60	19.60	8	0.9	2.6	45	17	0.0049	0.08	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.11	19.71	4.78	HGL Too High!
P51	STUB	DI22	1.00	19.60	19.60	15	2.2	1.8	0	10	0.0010	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	0.5	0.01	0.02	19.62	7.16	HGL Too High!
P28	DI22	MH11	1.00	19.58	19.58	15	0.6	0.5	90	30.3	0.0001	0.00	0	0.00	0.00	4.0	2.4	0.0	1.8	0.0	0	0.00	0.02	1.0	1.0	0.02	0.02	19.60	6.74	HGL Too High!
P29	DI8	MH11	1.00	19.58	19.58	15	0.5	0.4	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.58	6.92	HGL Too High!
P26	DI21	MH10	1.00	19.55	19.55	15	0.3	0.2	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.55	7.23	HGL Too High!
P23	DI20	MH9	1.00	19.54	19.54	15	0.4	0.3	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	19.54	7.38	HGL Too High!
P24	DI7	MH9	1.00	19.54	19.54	15	0.3	0.3	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.54	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	34.33	34.33	15	0.6	0.5	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.33	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	34.33	34.33	15	0.7	0.6	90	34	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.34	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	34.27	34.27	15	1.4	1.1	90	154	0.0004	0.06	0	0.00	0.00	0.3	0.4	0.0	0.6	0.0	90	0.00	0.01	1.0	0.5	0.01	0.06	34.33	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	34.19	34.19	15	3.2	2.6	90	23	0.0025	0.06	0	0.00	0.03	1.5	3.1	0.0	1.6	0.0	0	0.00	0.04	1.0	0.5	0.02	0.08	34.27	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	33.84	33.84	15	3.9	3.1	0	78	0.0036	0.28	0	0.00	0.04	8.4	0.4	0.0	2.6	0.0	90	0.07	0.15	1.0	0.5	0.08	0.35	34.19	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	33.61	33.61	15	3.8	3.1	0	54	0.0034	0.18	0	0.00	0.04	12.1	0.0	0.0	3.1	0.1	0	0.00	0.09	1.0	0.5	0.04	0.23	33.84	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	29.06	29.06	15	8.2	6.7	0	263	0.0161	4.25	0	0.00	0.17	11.5	14.6	5.3	5.2	0.1	90	0.29	0.61	1.0	0.5	0.31	4.55	33.61	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	25.78	25.78	15	11.4	9.3	0	96	0.0312	2.99	0	0.00	0.34	54.9	17.6	0.0	6.7	0.2	0	0.00	0.58	1.0	0.5	0.29	3.28	29.06	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	20.17	20.17	15	11.1	9.1	60	175	0.0298	5.21	0	0.00	0.32	106.0	0.0	0.0	9.3	0.5	0	0.00	0.79	1.0	0.5	0.39	5.61	25.78	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	19.48	19.48	24	10.7	3.4	84	41	0.0022	0.09	0	0.00	0.04	101.3	0.0	0.0	9.1	0.4	60	0.72	1.21	1.0	0.5	0.61	0.70	20.17	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	18.68	18.68	24	16.4	5.2	13	124	0.0052	0.65	0	0.00	0.11	36.2	5.0	5.5	3.4	0.1	84	0.12	0.29	1.0	0.5	0.14	0.79	19.48	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	18.36	18.36	24	20.3	6.5	78	8	0.0081	0.06	0	0.00	0.16	85.2	0.0	0.0	5.2	0.1	13	0.08	0.39	1.3	0.5	0.25	0.32	18.68	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.94	15.94	24	20.2	6.4	0	252	0.0080	2.02	0	0.00	0.16	131.3	0.0	0.0	6.5	0.2	78	0.43	0.82	1.0	0.5	0.41	2.43	18.36	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	14.22	14.22	24	18.9	6.0	25	221	0.0070	1.54	0	0.00	0.14	130.4	0.0	0.0	6.4	0.2	0	0.00	0.37	1.0	0.5	0.18	1.72	15.94	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**13.34**	**13.34**	**24**	**18.1**	**5.8**	**0**	**98**	**0.0064**	**0.63**	**0**	**0.00**	**0.13**	**113.6**	**0.0**	**0.0**	**6.0**	**0.2**	**25**	**0.17**	**0.49**	**1.0**	**0.5**	**0.25**	**0.88**	**14.22**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	35.09	35.09	4	0.9	10.6	0	16	0.2005	3.21	0	0.00	0.43	0.0	0.0	0.0	0.0	0.0	0	0.00	0.43	1.0	0.5	0.22	3.43	38.51	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	35.09	35.09	8	0.2	0.7	90	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	35.10	6.45	HGL Too High!
P3	DI14	DI13	1.00	35.09	35.09	15	0.4	0.3	90	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	35.09	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	34.27	34.27	15	1.9	1.6	0	15	0.0009	0.01	0	0.00	0.01	0.1	9.8	0.2	10.6	0.6	0	0.00	0.62	1.3	1.0	0.80	0.82	35.09	6.58	HGL Too High!
P2	DI2	DI1	1.00	34.20	34.20	15	0.4	0.3	70	69.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.20	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	2	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	34.19	34.19	15	0.7	0.5	111	3.34	0.0001	0.00	0	0.00	0.00	0.1	0.0	0.0	0.3	0.0	70	0.00	0.00	1.3	1.0	0.00	0.00	34.20	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	34.99	34.99	8	0.2	0.5	104	46	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	35.00	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	34.99	34.99	12	2.7	3.4	90	87	0.0049	0.42	0	0.00	0.05	0.0	0.0	0.0	0.0	0.0	0	0.00	0.05	1.0	1.0	0.05	0.47	35.46	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	33.61	33.61	10	2.8	5.2	90	87	0.0141	1.23	0	0.00	0.10	9.3	0.1	0.0	3.4	0.1	90	0.13	0.30	1.0	0.5	0.15	1.38	34.99	8.13	HGL Too High!
P42	DI31	MH22	1.00	29.47	29.47	15	1.3	1.1	7.5	55.8	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	29.49	5.12	HGL Too High!
P43	MH22	DI32	1.00	29.45	29.45	15	1.3	1.1	80	45.1	0.0004	0.02	0	0.00	0.00	1.4	0.0	0.0	1.1	0.0	7.5	0.00	0.01	1.0	0.5	0.01	0.02	29.47	5.45	HGL Too High!
P44	DI32	EX	1.00	29.06	29.06	15	4.6	3.8	90	59.3	0.0044	0.26	0	0.00	0.06	1.4	2.9	0.0	1.5	0.0	94	0.03	0.09	1.3	1.0	0.12	0.38	29.45	5.23	HGL Too High!
P46	DI34	DI33	1.00	29.49	29.49	15	0.3	0.2	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.49	5.47	HGL Too High!
P45	DI33	DI32	1.00	29.45	29.45	15	1.9	1.5	94	48.5	0.0007	0.04	0	0.00	0.01	0.1	0.0	0.0	0.2	0.0	19	0.00	0.01	1.3	1.0	0.01	0.05	29.49	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	20.17	20.17	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	20.17	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	33.78	33.78	12	1.4	1.8	0	47	0.0013	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	33.86	3.63	HGL Too High!
P48	DI40	DI41	0.80	33.78	33.78	12	0.4	0.5	90	82.1	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.79	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	33.61	33.61	12	2.0	2.6	95	41	0.0028	0.11	0	0.00	0.03	0.2	2.5	0.0	1.8	0.0	0	0.00	0.04	1.3	1.0	0.06	0.17	33.78	4.62	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 10 -year (50-year for sumps)

Location No.	From	To	Impervious Area, C = 0.95 to Inlet A_{imp} ft^2	Pervious Area, C = 0.18 to Inlet A_{perv} ft^2	Total Area A_{total} ft^2	Incremental Area ΔA Acres	Runoff Coefficient C	C x Δ A CxΔA Acres	Σ (C x Δ A) Σ CA Acres	Inlet Time T_c min	Time to Upper End T_c min	Rainfall Intensity I in/hr	Design Discharge Q cfs	Pipe Diameter D in	Length of Pipe L ft	Roughness Coefficient n	Friction Slope S_f ft/ft	Pipe Slope S_o ft/ft	Full Velocity V_{full} fps	Full Capacity Q_{full} cfs	Actual Velocity V_{act} fps	Flow Time In Pipe T_t min	Time to Lower End T_t min	Invert at Upper End Inv Up ft	Invert at Lower End Inv Dn ft	Capacity Check
MARKET ST RIVER WEST OUTFALL																										
SOUTH SECTION TO 24"																										
P4	DI15	MH1	3244	1216	4460	0.10	0.74	0.08	0.08	6.0	0.00	6.16	0.5	15	27.3	0.012	0.000045	0.005	4.1	5.0	2.5	0.19	6.19	4.49	4.35	Q ok
P5	MH1	MH2	1	0	1	0.00	0.95	0.00	0.16	6.0	6.19	6.11	0.9	18	82.7	0.012	0.000069	0.005	4.5	8.0	2.7	0.51	6.69	4.25	3.84	Q ok
P7	MH2	MH3	1	0	1	0.00	0.95	0.00	0.23	6.0	6.69	5.98	1.4	18	73.8	0.012	0.000152	0.005	4.6	8.1	3.2	0.39	7.08	3.81	3.44	Q ok
P10	MH3	MH4	1	0	1	0.00	0.95	0.00	0.43	6.0	7.08	5.88	2.5	18	53.7	0.012	0.000496	0.005	4.6	8.1	3.9	0.23	7.31	3.34	3.07	Q ok
P13	MH4	MH5	1	0	1	0.00	0.95	0.00	0.75	6.0	7.31	5.83	4.3	18	59.3	0.012	0.001460	0.005	4.3	7.7	4.4	0.22	7.53	2.97	2.70	Q ok
P15	MH5	MH20	1	0	1	0.00	0.95	0.00	1.13	6.0	7.53	5.78	6.5	24	104.1	0.012	0.000709	0.020	11.1	34.8	8.3	0.21	7.74	2.60	0.50	Q ok
P6	DI16	MH2	3400	1275	4675	0.11	0.74	0.08	0.08	6.0	0.00	6.16	0.5	15	29.3	0.012	0.000049	0.005	4.1	5.0	2.4	0.20	6.20	4.06	3.91	Q ok
P9	DI3	MH3	4110	3259	7369	0.17	0.61	0.10	0.10	6.0	0.00	6.16	0.6	15	18.3	0.012	0.000082	0.005	4.0	4.9	2.8	0.11	6.11	3.68	3.59	Q ok
P8	DI17	MH3	3878	2100	5978	0.14	0.68	0.09	0.09	6.0	0.00	6.16	0.6	15	31.3	0.012	0.000067	0.005	4.2	5.2	2.5	0.21	6.21	3.71	3.54	Q ok
P12	DI4	MH4	7109	2561	9670	0.22	0.75	0.17	0.17	6.0	0.00	6.73	1.1	15	20.1	0.012	0.000254	0.005	4.0	4.9	3.3	0.10	6.10	3.48	3.38	Q ok
P11	DI18	MH4	6435	2210	8645	0.20	0.75	0.15	0.15	6.0	0.00	6.70	1.0	15	28.4	0.012	0.000205	0.005	4.1	5.1	3.1	0.15	6.15	3.48	3.33	Q ok
P14	DI5	MH5	4974	2549	7523	0.17	0.69	0.12	0.12	6.0	0.00	6.16	0.7	15	22.6	0.012	0.000110	0.005	4.0	4.9	2.8	0.13	6.13	3.68	3.57	Q ok
P18	DI6	MH6	6937	1863	8800	0.20	0.79	0.16	0.16	6.0	0.00	6.16	1.0	15	38.0	0.012	0.000196	0.005	4.0	4.9	3.0	0.21	6.21	4.57	4.38	Q ok
P16	MH6	MH5	1	0	1	0.00	0.95	0.00	0.27	6.0	6.21	6.11	1.6	18	40.0	0.012	0.000203	0.011	6.8	12.1	4.8	0.14	6.35	3.77	3.32	Q ok
P17	DI19	MH6	4542	1703	6245	0.14	0.74	0.11	0.11	6.0	0.00	6.16	0.7	15	33.0	0.012	0.000087	0.005	4.0	4.9	2.8	0.20	6.20	4.19	4.02	Q ok
NORTH SECTION TO 24"																										
P32	DI23	MH12	5495	1914	7409	0.17	0.75	0.13	0.13	6.0	0.00	6.16	0.8	15	33.31	0.012	0.0001	0.005	4.1	5.0	2.9	0.19	6.19	3.98	3.81	Q ok
P31	DI9	MH12	4483	551	5034	0.12	0.87	0.10	0.10	6.0	0.00	6.16	0.6	15	18.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.11	6.11	3.86	3.77	Q ok
P30	MH12	MH11	1	0	1	0.00	0.95	0.00	0.23	6.0	6.19	6.11	1.4	18	50.1	0.012	0.0001	0.005	4.5	8.0	3.2	0.26	6.46	3.67	3.42	Q ok
P27	MH11	MH10	1	0	1	0.00	0.95	0.00	0.47	6.0	6.46	6.03	2.8	18	73.2	0.012	0.0006	0.005	4.6	8.1	4.1	0.30	6.75	3.39	3.02	Q ok
P25	MH10	MH9	1	0	1	0.00	0.95	0.00	0.54	6.0	6.75	5.96	3.2	24	69.68	0.012	0.0002	0.006	6.3	19.7	4.4	0.26	7.02	2.92	2.47	Q ok
P22	MH9	MH8	1	0	1	0.00	0.95	0.00	0.68	6.0	7.02	5.90	4.0	24	108.3	0.012	0.0003	0.005	5.5	17.3	4.5	0.40	7.42	2.47	1.93	Q ok
P20	MH8	MH21	1	0	1	0.00	0.95	0.00	0.90	6.0	7.42	5.80	5.2	24	57.3	0.012	0.0005	0.021	11.4	35.8	8.0	0.12	7.54	1.65	0.43	Q ok
P21	MH21	EXMH1	1	0	1	0.00	0.95	0.00	0.90	6.0	7.54	5.78	5.2	24	11.3	0.012	0.0004	0.005	5.7	17.9	4.8	0.04	7.58	0.33	0.27	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

Project:	South Market Street Infrastructure Improvements	Prepared by: RKK	Design Date: 2/23/2023	Sheet No.:	of		
County:	New Castle	Checked by: RKK	Model Date: 3/23/2023	Cm. No.:	20077		
Segment:	Market Street Existing Conditions 24" Outfall	Storm Frequency: 10	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P47	DI35	EXMH1	29988	0	29988	0.69	0.95	0.65	0.65	6.0	0.00	6.16	4.0	18	7.75	0.012	0.0013	0.008	5.8	10.3	5.3	0.02	6.02	-0.50	-0.56	Q ok
P-80	DI-80	MH-08	9967	0	9967	0.23	0.95	0.22	0.22	6.0	0.00	6.16	1.3	15	49	0.012	0.0004	0.009	5.5	6.8	4.1	0.20	6.20	4.53	4.07	Q ok
P52	TDI50	DI22	8815	0	8815	0.20	0.95	0.19	0.19	6.0	0.00	6.16	1.2	8	17	0.012	0.0082	0.010	3.8	1.3	4.3	0.07	6.07	3.92	3.75	Q ok
P51	STUB	DI22	21322	0	21322	0.49	0.95	0.47	0.47	6.0	0.00	6.16	2.9	15	10.02	0.012	0.0017	0.005	4.0	4.9	4.2	0.04	6.04	3.79	3.74	Q ok
P28	DI22	MH11	5555	1955	7510	0.17	0.75	0.13	0.13	6.0	0.00	6.16	0.8	15	30.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.18	6.18	3.64	3.49	Q ok
P29	DI8	MH11	5120	570	5690	0.13	0.87	0.11	0.11	6.0	0.00	6.16	0.7	15	18.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.11	6.11	3.64	3.55	Q ok
P26	DI21	MH10	2755	930	3685	0.08	0.76	0.06	0.06	6.0	0.00	6.16	0.4	15	18.3	0.012	0.0000	0.005	4.0	4.9	2.4	0.13	6.13	4.02	3.93	Q ok
P23	DI20	MH9	3213	1102	4315	0.10	0.75	0.07	0.07	6.0	0.00	6.16	0.5	15	29.3	0.012	0.0000	0.005	4.0	4.9	2.4	0.20	6.20	4.53	4.38	Q ok
P24	DI7	MH9	3164	527	3691	0.08	0.84	0.07	0.07	6.0	0.00	6.16	0.4	15	28.02	0.012	0.0000	0.005	4.0	4.9	2.4	0.19	6.19	4.38	4.24	Q ok
SOUTH SECTION LOW TRUNK TO 24" OUTFALL																										
CRB-P72	CRB-DI72	CRB-MH-74	6086	0	6086	0.14	0.95	0.13	0.13	6.0	0.00	6.16	0.8	15	16	0.012	0.0001	0.019	7.8	9.6	4.7	0.06	6.06	2.60	2.30	Q ok
CRB-P73	CRB-DI73	CRB-MH-74	7042	0	7042	0.16	0.95	0.15	0.15	6.0	0.00	6.16	0.9	15	34	0.012	0.0002	0.005	4.0	4.9	3.0	0.19	6.19	1.92	1.75	Q ok
CRB-P74	CRB-MH-74	CRB-MH-67	1	0	1	0.00	0.95	0.00	0.29	6.0	6.19	6.11	1.7	15	154	0.012	0.0006	0.005	4.1	5.1	3.7	0.69	6.88	1.65	0.84	Q ok
EXP2	CRB-MH-67	EXMH3	1	0	1	0.00	0.95	0.00	0.70	6.0	6.88	5.93	4.2	15	23	0.013	0.0042	***0.003***	***2.7***	3.3	2.2	0.17	7.05	-1.14	-1.20	Undersized!
EXP3	EXMH3	EXMH4	1	0	1	0.00	0.95	0.00	0.85	6.0	7.05	5.88	5.0	15	78	0.013	0.0059	***0.003***	***2.7***	3.3	2.2	0.59	7.64	-1.20	-1.40	Undersized!
EXP4	EXMH4	EXMH5	1	0	1	0.00	0.95	0.00	0.85	6.0	7.64	5.75	4.9	15	54	0.013	0.0057	***0.003***	***2.7***	3.3	2.2	0.41	8.05	-1.40	-1.54	Undersized!
EXP5	EXMH5	EXMH6	1	0	1	0.00	0.95	0.00	1.89	6.0	8.05	5.62	10.6	15	263	0.013	0.0269	***0.003***	***2.7***	3.3	2.2	2.00	10.05	-1.54	-2.22	Undersized!
EXP6	EXMH6	EXMH7	1	0	1	0.00	0.95	0.00	2.88	6.0	10.05	5.11	14.7	15	96	0.013	0.0521	***0.003***	***2.7***	3.3	2.2	0.73	10.78	-2.22	-2.47	Undersized!
EXP7	EXMH7	EXMH8	1	0	1	0.00	0.95	0.00	2.88	6.0	10.78	5.00	14.4	15	175	0.013	0.0498	***0.003***	***2.7***	3.3	2.2	1.33	12.11	-2.47	-2.92	Undersized!
EXP8	EXMH8	EXMH9	1	0	1	0.00	0.95	0.00	2.88	6.0	12.11	4.79	13.8	24	41	0.013	0.0037	0.009	6.8	21.4	7.3	0.09	12.20	-2.92	-3.29	Q ok
EXP9	EXMH9	EXMH10	1	0	1	0.00	0.95	0.00	4.43	6.0	12.20	4.78	21.2	24	124	0.013	0.0088	0.009	6.8	21.4	8.0	0.26	12.46	-3.29	-4.40	Q ok
EXP10	EXMH10	EXMH11	1	0	1	0.00	0.95	0.00	5.57	6.0	12.46	4.73	26.3	24	8	0.013	0.0135	***0.001***	***2.7***	8.5	2.2	0.06	12.52	-4.40	-4.41	Undersized!
EXP11	EXMH11	EXMH12	1	0	1	0.00	0.95	0.00	5.57	6.0	12.52	4.73	26.3	24	252	0.013	0.0135	***0.001***	***2.7***	8.5	2.2	1.90	14.42	-4.41	-4.76	Undersized!
EXP12	EXMH12	EXMH13	1	0	1	0.00	0.95	0.00	5.57	6.0	14.42	4.43	24.6	24	221	0.013	0.0119	***0.001***	***2.7***	8.5	2.2	1.67	16.09	-4.76	-5.07	Undersized!
EXP13	**EXMH13**	**OUTFALL**	**1**	**0**	**1**	**0.00**	0.95	**0.00**	**5.57**	**6.0**	**16.09**	4.24	23.6	**24**	**98**	**0.013**	**0.0109**	***0.001***	***2.7***	**8.5**	**2.2**	**0.74**	**16.83**	**-5.07**	**-5.21**	**Undersized!**
ROOF	COLLINS	MSS DI-13	8875	0	8875	0.20	0.95	0.19	0.19	6.0	0.00	6.16	1.2	4	16	0.012	0.3346	0.019	3.2	0.3	2.7	0.10	6.10	2.60	2.30	Undersized!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 10 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
CRB-P75	TD-03	MSS DI-13	2341	0	2341	0.05	0.95	0.05	0.05	6.0	0.00	6.16	**0.31**	8	33	0.011	0.000485	0.0348	7.6	**2.7**	4.6	0.12	6.12	4.57	3.42	Q ok
P3	DI14	DI13	3876	441	4317	0.10	0.87	0.09	0.09	6.0	0.00	6.16	0.5	15	69.3	0.012	0.0001	0.005	4.0	4.9	2.4	0.48	6.48	4.03	3.68	Q ok
EXP1	DI13	MH67	3876	441	4317	0.10	0.87	0.09	0.42	6.0	6.48	6.03	2.5	15	15	0.013	0.0015	***0.003***	***2.7***	3.3	3.0	0.08	6.56	-1.10	-1.14	Q ok
P2	DI2	DI1	3846	1139	4985	0.11	0.77	0.09	0.09	6.0	0.00	6.16	0.5	15	69.3	0.012	0.0001	0.005	4.0	4.9	2.4	0.48	6.48	4.03	3.68	Q ok
P1	DI1	EXMH	2301	1082	3383	0.08	0.70	0.05	0.14	6.0	6.48	6.03	0.9	15	3.34	0.012	0.0002	0.005	4.0	4.9	2.8	0.02	6.50	3.39	3.37	Q ok
CRB-P84	TD-04	EXMH	1667	0	1667	0.04	0.95	0.04	0.04	6.0	0.00	6.16	**0.22**	8	46	0.011	0.000246	0.0383	8.0	**2.8**	4.8	0.16	6.16	6.26	4.50	Q ok
EXP15	EXDI	EXMH	24757	6130	30887	0.71	0.80	0.57	0.57	6.0	0.00	6.16	**3.48**	12	87	0.012	0.008144	0.0049	3.5	**2.7**	2.8	0.51	6.51	2.00	1.57	Undersized!
EXP16	EXMH	EXMH5	1	0	1	0.00	0.95	0.00	0.60	6.0	6.51	6.03	**3.63**	10	87	0.012	0.023384	0.0049	3.1	**1.7**	2.5	0.58	7.09	2.00	1.57	Undersized!
P42	DI31	MH22	12796.5	0	12797	0.29	0.95	0.28	0.28	6.0	0.00	6.16	1.7	15	55.8	0.012	0.0006	0.005	4.0	5.0	3.6	0.26	6.26	2.00	1.72	Q ok
P43	MH22	DI32	1	0	1	0.00	0.95	0.00	0.28	6.0	6.26	6.08	1.7	15	45.1	0.012	0.0006	0.005	4.1	5.0	3.7	0.21	6.46	1.62	1.39	Q ok
P44	DI32	EX	14459.5	0	14460	0.33	0.95	0.32	1.00	6.0	6.46	6.03	6.0	15	59.3	0.012	0.0074	0.030	9.9	12.1	9.8	0.10	6.56	1.29	0.70	Q ok
P46	DI34	DI33	2420	0	2420	0.06	0.95	0.05	0.05	6.0	0.00	6.16	0.3	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.0	0.32	6.32	2.00	1.82	Q ok
P45	DI33	DI32	15975	0	15975	0.37	0.95	0.35	0.40	6.0	6.32	6.08	2.4	15	48.5	0.012	0.0012	0.007	4.7	5.8	4.3	0.19	6.50	1.72	1.39	Q ok
EXP17	EXMH	EXMH8	1	0	1	0.00	0.95	0.00	0.00	6.0	0.00	6.16	0.0	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.0	0.32	6.32	2.00	1.82	Q ok
EX-P LOT	EXDI LOT	DI-MSS-41	13430	0	13430	0.31	0.95	0.29	0.29	6.0	0.00	6.16	**1.80**	12	47	0.012	0.002187	0.0074	4.2	**3.3**	4.3	0.18	6.18	2.50	2.15	Q ok
P48	DI40	DI41	3590	0	3590	0.08	0.95	0.08	0.08	6.0	0.00	6.16	0.5	12	82.1	0.012	0.0002	0.005	3.5	2.7	2.6	0.53	6.53	2.56	2.15	Q ok
P-MSS-48A	DI-MSS-41	EX-MH LOW	3072	0	3072	0.07	0.95	0.07	0.44	6.0	6.53	6.03	**2.64**	12	41	0.012	0.004691	0.0051	3.5	**2.8**	4.1	0.17	6.69	2.05	1.84	Q ok

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	12.54	12.54	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.54	7.41	
P5	MH1	MH2	1.20	12.53	12.53	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	12.54	7.93	HGL Too High!
P7	MH2	MH3	1.20	12.52	12.52	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	12.53	7.65	HGL Too High!
P10	MH3	MH4	1.20	12.49	12.49	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	12.52	7.28	HGL Too High!
P13	MH4	MH5	1.20	12.38	12.38	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	12.49	7.09	HGL Too High!
P15	MH5	MH20	1.60	12.25	12.25	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	12.38	7.40	HGL Too High!
P6	DI16	MH2	1.00	12.53	12.53	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.53	7.33	HGL Too High!
P9	DI3	MH3	1.00	12.52	12.52	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.52	6.62	HGL Too High!
P8	DI17	MH3	1.00	12.52	12.52	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.52	6.96	HGL Too High!
P12	DI4	MH4	1.00	12.49	12.49	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.49	6.48	HGL Too High!
P11	DI18	MH4	1.00	12.49	12.49	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.49	6.56	HGL Too High!
P14	DI5	MH5	1.00	12.38	12.38	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.38	6.61	HGL Too High!
P18	DI6	MH6	1.00	12.39	12.39	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.40	7.13	HGL Too High!
P16	MH6	MH5	1.20	12.38	12.38	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	12.39	7.55	HGL Too High!
P17	DI19	MH6	1.00	12.39	12.39	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.40	7.08	HGL Too High!
P32	DI23	MH12	1.00	13.77	13.77	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.77	4.24	HGL Too High!
P31	DI9	MH12	1.00	13.77	13.77	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.77	7.13	HGL Too High!
P30	MH12	MH11	1.60	13.75	13.75	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	13.77	7.48	HGL Too High!
P27	MH11	MH10	1.60	13.71	13.71	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	13.75	7.21	HGL Too High!
P25	MH10	MH9	1.60	13.69	13.69	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	13.71	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.65	13.65	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	13.69	7.85	HGL Too High!
P20	MH8	MH21	1.60	13.61	13.61	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	13.65	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	13.58	13.58	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	13.61	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	13.58	13.58	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	13.61	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	13.65	13.65	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	13.68	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	13.79	13.79	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	13.97	4.78	HGL Too High!
P51	STUB	DI22	1.00	13.79	13.79	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	13.82	7.16	HGL Too High!
P28	DI22	MH11	1.00	13.75	13.75	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	13.79	6.74	HGL Too High!
P29	DI8	MH11	1.00	13.75	13.75	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.76	6.92	HGL Too High!
P26	DI21	MH10	1.00	13.71	13.71	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.71	7.23	HGL Too High!
P23	DI20	MH9	1.00	13.69	13.69	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	13.69	7.38	HGL Too High!
P24	DI7	MH9	1.00	13.69	13.69	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.69	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	38.40	38.40	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	38.41	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	38.40	38.40	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	38.41	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	38.30	38.30	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	38.40	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	38.17	38.17	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	38.30	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	37.58	37.58	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	38.17	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	37.20	37.20	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	37.58	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	29.61	29.61	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	37.20	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	24.12	24.12	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	29.61	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	14.75	14.75	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	24.12	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	13.58	13.58	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	14.75	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	12.25	12.25	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	13.58	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	11.72	11.72	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	12.25	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	7.62	7.62	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	11.72	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	4.69	4.69	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	7.62	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.20**	**3.20**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**4.69**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	39.66	39.66	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	45.38	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	39.66	39.66	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	39.68	6.45	HGL Too High!
P3	DI14	DI13	1.00	39.66	39.66	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	39.67	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	38.30	38.30	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	39.66	6.58	HGL Too High!
P2	DI2	DI1	1.00	38.18	38.18	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	38.18	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	38.17	38.17	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	38.18	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	39.48	39.48	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	39.49	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	39.48	39.48	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	40.26	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	37.20	37.20	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	39.48	8.13	HGL Too High!
P42	DI31	MH22	1.00	30.28	30.28	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	30.33	5.12	HGL Too High!
P43	MH22	DI32	1.00	30.25	30.25	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	30.28	5.45	HGL Too High!
P44	DI32	EX	1.00	29.61	29.61	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	30.25	5.23	HGL Too High!
P46	DI34	DI33	1.00	30.33	30.33	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.33	5.47	HGL Too High!
P45	DI33	DI32	1.00	30.25	30.25	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	30.33	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	14.75	14.75	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.75	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	37.49	37.49	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	37.61	3.63	HGL Too High!
P48	DI40	DI41	0.80	37.49	37.49	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	37.50	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	37.20	37.20	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	37.49	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	12.74	12.74	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.74	7.41	
P5	MH1	MH2	1.20	12.73	12.73	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	12.74	7.93	HGL Too High!
P7	MH2	MH3	1.20	12.72	12.72	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	12.73	7.65	HGL Too High!
P10	MH3	MH4	1.20	12.69	12.69	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	12.72	7.28	HGL Too High!
P13	MH4	MH5	1.20	12.58	12.58	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	12.69	7.09	HGL Too High!
P15	MH5	MH20	1.60	12.45	12.45	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	12.58	7.40	HGL Too High!
P6	DI16	MH2	1.00	12.73	12.73	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.73	7.33	HGL Too High!
P9	DI3	MH3	1.00	12.72	12.72	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.72	6.62	HGL Too High!
P8	DI17	MH3	1.00	12.72	12.72	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.72	6.96	HGL Too High!
P12	DI4	MH4	1.00	12.69	12.69	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.69	6.48	HGL Too High!
P11	DI18	MH4	1.00	12.69	12.69	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.69	6.56	HGL Too High!
P14	DI5	MH5	1.00	12.58	12.58	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.58	6.61	HGL Too High!
P18	DI6	MH6	1.00	12.59	12.59	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	12.60	7.13	HGL Too High!
P16	MH6	MH5	1.20	12.58	12.58	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	12.59	7.55	HGL Too High!
P17	DI19	MH6	1.00	12.59	12.59	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	12.60	7.08	HGL Too High!
P32	DI23	MH12	1.00	13.97	13.97	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	13.97	4.24	HGL Too High!
P31	DI9	MH12	1.00	13.97	13.97	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.97	7.13	HGL Too High!
P30	MH12	MH11	1.60	13.95	13.95	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	13.97	7.48	HGL Too High!
P27	MH11	MH10	1.60	13.91	13.91	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	13.95	7.21	HGL Too High!
P25	MH10	MH9	1.60	13.89	13.89	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	13.91	7.54	HGL Too High!
P22	MH9	MH8	1.60	13.85	13.85	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	13.89	7.85	HGL Too High!
P20	MH8	MH21	1.60	13.81	13.81	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	13.85	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	13.78	13.78	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	13.81	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	13.78	13.78	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	13.81	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	13.85	13.85	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	13.88	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_f +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	13.99	13.99	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	14.17	4.78	HGL Too High!
P51	STUB	DI22	1.00	13.99	13.99	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	14.02	7.16	HGL Too High!
P28	DI22	MH11	1.00	13.95	13.95	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	13.99	6.74	HGL Too High!
P29	DI8	MH11	1.00	13.95	13.95	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.96	6.92	HGL Too High!
P26	DI21	MH10	1.00	13.91	13.91	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.91	7.23	HGL Too High!
P23	DI20	MH9	1.00	13.89	13.89	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	13.89	7.38	HGL Too High!
P24	DI7	MH9	1.00	13.89	13.89	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	13.89	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	38.60	38.60	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	38.61	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	38.60	38.60	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	38.61	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	38.50	38.50	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	38.60	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	38.37	38.37	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	38.50	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	37.78	37.78	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	38.37	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	37.40	37.40	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	37.78	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	29.81	29.81	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	37.40	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	24.32	24.32	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	29.81	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	14.95	14.95	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	24.32	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	13.78	13.78	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	14.95	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	12.45	12.45	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	13.78	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	11.92	11.92	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	12.45	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	7.82	7.82	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	11.92	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	4.89	4.89	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	7.82	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.40**	**3.40**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**4.89**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	39.86	39.86	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	45.58	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	39.86	39.86	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	39.88	6.45	HGL Too High!
P3	DI14	DI13	1.00	39.86	39.86	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	39.87	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	38.50	38.50	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	39.86	6.58	HGL Too High!
P2	DI2	DI1	1.00	38.38	38.38	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	38.38	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	38.37	38.37	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	38.38	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	39.68	39.68	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	39.69	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	39.68	39.68	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	40.46	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	37.40	37.40	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	39.68	8.13	HGL Too High!
P42	DI31	MH22	1.00	30.48	30.48	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	30.53	5.12	HGL Too High!
P43	MH22	DI32	1.00	30.45	30.45	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	30.48	5.45	HGL Too High!
P44	DI32	EX	1.00	29.81	29.81	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	30.45	5.23	HGL Too High!
P46	DI34	DI33	1.00	30.53	30.53	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.53	5.47	HGL Too High!
P45	DI33	DI32	1.00	30.45	30.45	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	30.53	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	14.95	14.95	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	14.95	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	37.69	37.69	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	37.81	3.63	HGL Too High!
P48	DI40	DI41	0.80	37.69	37.69	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	37.70	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	37.40	37.40	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	37.69	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	16.24	16.24	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.24	7.41	
P5	MH1	MH2	1.20	16.23	16.23	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	16.24	7.93	HGL Too High!
P7	MH2	MH3	1.20	16.22	16.22	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	16.23	7.65	HGL Too High!
P10	MH3	MH4	1.20	16.19	16.19	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	16.22	7.28	HGL Too High!
P13	MH4	MH5	1.20	16.08	16.08	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	16.19	7.09	HGL Too High!
P15	MH5	MH20	1.60	15.95	15.95	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	16.08	7.40	HGL Too High!
P6	DI16	MH2	1.00	16.23	16.23	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.23	7.33	HGL Too High!
P9	DI3	MH3	1.00	16.22	16.22	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.22	6.62	HGL Too High!
P8	DI17	MH3	1.00	16.22	16.22	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.22	6.96	HGL Too High!
P12	DI4	MH4	1.00	16.19	16.19	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.19	6.48	HGL Too High!
P11	DI18	MH4	1.00	16.19	16.19	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.19	6.56	HGL Too High!
P14	DI5	MH5	1.00	16.08	16.08	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.08	6.61	HGL Too High!
P18	DI6	MH6	1.00	16.09	16.09	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.10	7.13	HGL Too High!
P16	MH6	MH5	1.20	16.08	16.08	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	16.09	7.55	HGL Too High!
P17	DI19	MH6	1.00	16.09	16.09	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.10	7.08	HGL Too High!
P32	DI23	MH12	1.00	17.47	17.47	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.47	4.24	HGL Too High!
P31	DI9	MH12	1.00	17.47	17.47	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.47	7.13	HGL Too High!
P30	MH12	MH11	1.60	17.45	17.45	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	17.47	7.48	HGL Too High!
P27	MH11	MH10	1.60	17.41	17.41	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	17.45	7.21	HGL Too High!
P25	MH10	MH9	1.60	17.39	17.39	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	17.41	7.54	HGL Too High!
P22	MH9	MH8	1.60	17.35	17.35	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	17.39	7.85	HGL Too High!
P20	MH8	MH21	1.60	17.31	17.31	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	17.35	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	17.28	17.28	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	17.31	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	17.28	17.28	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	17.31	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	17.35	17.35	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	17.38	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	17.49	17.49	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	17.67	4.78	HGL Too High!
P51	STUB	DI22	1.00	17.49	17.49	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	17.52	7.16	HGL Too High!
P28	DI22	MH11	1.00	17.45	17.45	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	17.49	6.74	HGL Too High!
P29	DI8	MH11	1.00	17.45	17.45	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.46	6.92	HGL Too High!
P26	DI21	MH10	1.00	17.41	17.41	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.41	7.23	HGL Too High!
P23	DI20	MH9	1.00	17.39	17.39	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	17.39	7.38	HGL Too High!
P24	DI7	MH9	1.00	17.39	17.39	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.39	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	42.10	42.10	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	42.11	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	42.10	42.10	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	42.11	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	42.00	42.00	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	42.10	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	41.87	41.87	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	42.00	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	41.28	41.28	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	41.87	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	40.90	40.90	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	41.28	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	33.31	33.31	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	40.90	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	27.82	27.82	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	33.31	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	18.45	18.45	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	27.82	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	17.28	17.28	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	18.45	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	15.95	15.95	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	17.28	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	15.42	15.42	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	15.95	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	11.32	11.32	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	15.42	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	8.39	8.39	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	11.32	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**6.90**	**6.90**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**8.39**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	43.36	43.36	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	49.08	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	43.36	43.36	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	43.38	6.45	HGL Too High!
P3	DI14	DI13	1.00	43.36	43.36	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	43.37	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	42.00	42.00	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	43.36	6.58	HGL Too High!
P2	DI2	DI1	1.00	41.88	41.88	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	41.88	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	41.87	41.87	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	41.88	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	43.18	43.18	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	43.19	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	43.18	43.18	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	43.96	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	40.90	40.90	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	43.18	8.13	HGL Too High!
P42	DI31	MH22	1.00	33.98	33.98	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	34.03	5.12	HGL Too High!
P43	MH22	DI32	1.00	33.95	33.95	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	33.98	5.45	HGL Too High!
P44	DI32	EX	1.00	33.31	33.31	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	33.95	5.23	HGL Too High!
P46	DI34	DI33	1.00	34.03	34.03	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.03	5.47	HGL Too High!
P45	DI33	DI32	1.00	33.95	33.95	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	34.03	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	18.45	18.45	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	18.45	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	41.19	41.19	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	41.31	3.63	HGL Too High!
P48	DI40	DI41	0.80	41.19	41.19	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	41.20	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	40.90	40.90	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	41.19	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	16.74	16.74	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.74	7.41	
P5	MH1	MH2	1.20	16.73	16.73	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	16.74	7.93	HGL Too High!
P7	MH2	MH3	1.20	16.72	16.72	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	16.73	7.65	HGL Too High!
P10	MH3	MH4	1.20	16.69	16.69	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	16.72	7.28	HGL Too High!
P13	MH4	MH5	1.20	16.58	16.58	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	16.69	7.09	HGL Too High!
P15	MH5	MH20	1.60	16.45	16.45	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	16.58	7.40	HGL Too High!
P6	DI16	MH2	1.00	16.73	16.73	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.73	7.33	HGL Too High!
P9	DI3	MH3	1.00	16.72	16.72	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.72	6.62	HGL Too High!
P8	DI17	MH3	1.00	16.72	16.72	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.72	6.96	HGL Too High!
P12	DI4	MH4	1.00	16.69	16.69	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.69	6.48	HGL Too High!
P11	DI18	MH4	1.00	16.69	16.69	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.69	6.56	HGL Too High!
P14	DI5	MH5	1.00	16.58	16.58	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.58	6.61	HGL Too High!
P18	DI6	MH6	1.00	16.59	16.59	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.60	7.13	HGL Too High!
P16	MH6	MH5	1.20	16.58	16.58	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	16.59	7.55	HGL Too High!
P17	DI19	MH6	1.00	16.59	16.59	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.60	7.08	HGL Too High!
P32	DI23	MH12	1.00	17.97	17.97	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.97	4.24	HGL Too High!
P31	DI9	MH12	1.00	17.97	17.97	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.97	7.13	HGL Too High!
P30	MH12	MH11	1.60	17.95	17.95	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	17.97	7.48	HGL Too High!
P27	MH11	MH10	1.60	17.91	17.91	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	17.95	7.21	HGL Too High!
P25	MH10	MH9	1.60	17.89	17.89	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	17.91	7.54	HGL Too High!
P22	MH9	MH8	1.60	17.85	17.85	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	17.89	7.85	HGL Too High!
P20	MH8	MH21	1.60	17.81	17.81	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	17.85	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	17.78	17.78	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	17.81	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	17.78	17.78	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	17.81	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	17.85	17.85	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	17.88	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	17.99	17.99	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	18.17	4.78	HGL Too High!
P51	STUB	DI22	1.00	17.99	17.99	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	18.02	7.16	HGL Too High!
P28	DI22	MH11	1.00	17.95	17.95	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	17.99	6.74	HGL Too High!
P29	DI8	MH11	1.00	17.95	17.95	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.96	6.92	HGL Too High!
P26	DI21	MH10	1.00	17.91	17.91	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.91	7.23	HGL Too High!
P23	DI20	MH9	1.00	17.89	17.89	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	17.89	7.38	HGL Too High!
P24	DI7	MH9	1.00	17.89	17.89	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.89	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	42.60	42.60	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	42.61	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	42.60	42.60	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	42.61	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	42.50	42.50	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	42.60	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	42.37	42.37	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	42.50	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	41.78	41.78	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	42.37	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	41.40	41.40	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	41.78	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	33.81	33.81	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	41.40	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	28.32	28.32	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	33.81	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	18.95	18.95	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	28.32	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	17.78	17.78	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	18.95	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	16.45	16.45	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	17.78	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	15.92	15.92	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	16.45	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	11.82	11.82	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	15.92	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	8.89	8.89	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	11.82	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.40**	**7.40**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**8.89**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	43.86	43.86	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	49.58	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	43.86	43.86	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	43.88	6.45	HGL Too High!
P3	DI14	DI13	1.00	43.86	43.86	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	43.87	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	42.50	42.50	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	43.86	6.58	HGL Too High!
P2	DI2	DI1	1.00	42.38	42.38	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	42.38	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	42.37	42.37	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	42.38	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	43.68	43.68	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	43.69	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	43.68	43.68	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	44.46	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	41.40	41.40	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	43.68	8.13	HGL Too High!
P42	DI31	MH22	1.00	34.48	34.48	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	34.53	5.12	HGL Too High!
P43	MH22	DI32	1.00	34.45	34.45	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	34.48	5.45	HGL Too High!
P44	DI32	EX	1.00	33.81	33.81	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	34.45	5.23	HGL Too High!
P46	DI34	DI33	1.00	34.53	34.53	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.53	5.47	HGL Too High!
P45	DI33	DI32	1.00	34.45	34.45	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	34.53	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	18.95	18.95	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	18.95	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	41.69	41.69	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	41.81	3.63	HGL Too High!
P48	DI40	DI41	0.80	41.69	41.69	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	41.70	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	41.40	41.40	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	41.69	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	17.14	17.14	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.14	7.41	
P5	MH1	MH2	1.20	17.13	17.13	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	17.14	7.93	HGL Too High!
P7	MH2	MH3	1.20	17.12	17.12	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	17.13	7.65	HGL Too High!
P10	MH3	MH4	1.20	17.09	17.09	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	17.12	7.28	HGL Too High!
P13	MH4	MH5	1.20	16.98	16.98	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	17.09	7.09	HGL Too High!
P15	MH5	MH20	1.60	16.85	16.85	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	16.98	7.40	HGL Too High!
P6	DI16	MH2	1.00	17.13	17.13	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.13	7.33	HGL Too High!
P9	DI3	MH3	1.00	17.12	17.12	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.12	6.62	HGL Too High!
P8	DI17	MH3	1.00	17.12	17.12	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.12	6.96	HGL Too High!
P12	DI4	MH4	1.00	17.09	17.09	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.09	6.48	HGL Too High!
P11	DI18	MH4	1.00	17.09	17.09	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.09	6.56	HGL Too High!
P14	DI5	MH5	1.00	16.98	16.98	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.98	6.61	HGL Too High!
P18	DI6	MH6	1.00	16.99	16.99	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.00	7.13	HGL Too High!
P16	MH6	MH5	1.20	16.98	16.98	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	16.99	7.55	HGL Too High!
P17	DI19	MH6	1.00	16.99	16.99	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.00	7.08	HGL Too High!
P32	DI23	MH12	1.00	18.37	18.37	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.37	4.24	HGL Too High!
P31	DI9	MH12	1.00	18.37	18.37	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.37	7.13	HGL Too High!
P30	MH12	MH11	1.60	18.35	18.35	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	18.37	7.48	HGL Too High!
P27	MH11	MH10	1.60	18.31	18.31	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	18.35	7.21	HGL Too High!
P25	MH10	MH9	1.60	18.29	18.29	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	18.31	7.54	HGL Too High!
P22	MH9	MH8	1.60	18.25	18.25	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	18.29	7.85	HGL Too High!
P20	MH8	MH21	1.60	18.21	18.21	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	18.25	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	18.18	18.18	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	18.21	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	18.18	18.18	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	18.21	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	18.25	18.25	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	18.28	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	18.39	18.39	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	18.57	4.78	HGL Too High!
P51	STUB	DI22	1.00	18.39	18.39	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	18.42	7.16	HGL Too High!
P28	DI22	MH11	1.00	18.35	18.35	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	18.39	6.74	HGL Too High!
P29	DI8	MH11	1.00	18.35	18.35	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.36	6.92	HGL Too High!
P26	DI21	MH10	1.00	18.31	18.31	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.31	7.23	HGL Too High!
P23	DI20	MH9	1.00	18.29	18.29	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	18.29	7.38	HGL Too High!
P24	DI7	MH9	1.00	18.29	18.29	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.29	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	43.00	43.00	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	43.01	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	43.00	43.00	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	43.01	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	42.90	42.90	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	43.00	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	42.77	42.77	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	42.90	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	42.18	42.18	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	42.77	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	41.80	41.80	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	42.18	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	34.21	34.21	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	41.80	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	28.72	28.72	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	34.21	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	19.35	19.35	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	28.72	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	18.18	18.18	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	19.35	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	16.85	16.85	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	18.18	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	16.32	16.32	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	16.85	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.22	12.22	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	16.32	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.29	9.29	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	12.22	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.80**	**7.80**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**9.29**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	44.26	44.26	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	49.98	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	44.26	44.26	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	44.28	6.45	HGL Too High!
P3	DI14	DI13	1.00	44.26	44.26	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	44.27	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	42.90	42.90	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	44.26	6.58	HGL Too High!
P2	DI2	DI1	1.00	42.78	42.78	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	42.78	6.84	HGL Too High!

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County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	42.77	42.77	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	42.78	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	44.08	44.08	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	44.09	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	44.08	44.08	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	44.86	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	41.80	41.80	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	44.08	8.13	HGL Too High!
P42	DI31	MH22	1.00	34.88	34.88	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	34.93	5.12	HGL Too High!
P43	MH22	DI32	1.00	34.85	34.85	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	34.88	5.45	HGL Too High!
P44	DI32	EX	1.00	34.21	34.21	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	34.85	5.23	HGL Too High!
P46	DI34	DI33	1.00	34.93	34.93	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.93	5.47	HGL Too High!
P45	DI33	DI32	1.00	34.85	34.85	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	34.93	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	19.35	19.35	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	19.35	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	42.09	42.09	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	42.21	3.63	HGL Too High!
P48	DI40	DI41	0.80	42.09	42.09	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	42.10	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	41.80	41.80	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	42.09	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	17.64	17.64	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.64	7.41	
P5	MH1	MH2	1.20	17.63	17.63	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	17.64	7.93	HGL Too High!
P7	MH2	MH3	1.20	17.62	17.62	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	17.63	7.65	HGL Too High!
P10	MH3	MH4	1.20	17.59	17.59	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	17.62	7.28	HGL Too High!
P13	MH4	MH5	1.20	17.48	17.48	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	17.59	7.09	HGL Too High!
P15	MH5	MH20	1.60	17.35	17.35	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	17.48	7.40	HGL Too High!
P6	DI16	MH2	1.00	17.63	17.63	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.63	7.33	HGL Too High!
P9	DI3	MH3	1.00	17.62	17.62	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.62	6.62	HGL Too High!
P8	DI17	MH3	1.00	17.62	17.62	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.62	6.96	HGL Too High!
P12	DI4	MH4	1.00	17.59	17.59	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.59	6.48	HGL Too High!
P11	DI18	MH4	1.00	17.59	17.59	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.59	6.56	HGL Too High!
P14	DI5	MH5	1.00	17.48	17.48	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.48	6.61	HGL Too High!
P18	DI6	MH6	1.00	17.49	17.49	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	17.50	7.13	HGL Too High!
P16	MH6	MH5	1.20	17.48	17.48	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	17.49	7.55	HGL Too High!
P17	DI19	MH6	1.00	17.49	17.49	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	17.50	7.08	HGL Too High!
P32	DI23	MH12	1.00	18.87	18.87	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.87	4.24	HGL Too High!
P31	DI9	MH12	1.00	18.87	18.87	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.87	7.13	HGL Too High!
P30	MH12	MH11	1.60	18.85	18.85	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	18.87	7.48	HGL Too High!
P27	MH11	MH10	1.60	18.81	18.81	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	18.85	7.21	HGL Too High!
P25	MH10	MH9	1.60	18.79	18.79	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	18.81	7.54	HGL Too High!
P22	MH9	MH8	1.60	18.75	18.75	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	18.79	7.85	HGL Too High!
P20	MH8	MH21	1.60	18.71	18.71	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	18.75	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	18.68	18.68	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	18.71	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	18.68	18.68	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	18.71	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	18.75	18.75	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	18.78	7.34	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	18.89	18.89	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	19.07	4.78	HGL Too High!
P51	STUB	DI22	1.00	18.89	18.89	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	18.92	7.16	HGL Too High!
P28	DI22	MH11	1.00	18.85	18.85	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	18.89	6.74	HGL Too High!
P29	DI8	MH11	1.00	18.85	18.85	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.86	6.92	HGL Too High!
P26	DI21	MH10	1.00	18.81	18.81	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.81	7.23	HGL Too High!
P23	DI20	MH9	1.00	18.79	18.79	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	18.79	7.38	HGL Too High!
P24	DI7	MH9	1.00	18.79	18.79	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.79	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	43.50	43.50	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	43.51	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	43.50	43.50	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	43.51	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	43.40	43.40	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	43.50	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	43.27	43.27	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	43.40	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	42.68	42.68	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	43.27	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	42.30	42.30	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	42.68	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	34.71	34.71	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	42.30	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	29.22	29.22	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	34.71	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	19.85	19.85	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	29.22	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	18.68	18.68	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	19.85	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	17.35	17.35	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	18.68	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	16.82	16.82	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	17.35	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.72	12.72	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	16.82	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.79	9.79	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	12.72	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**8.30**	**8.30**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**9.79**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	44.76	44.76	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	50.48	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	44.76	44.76	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	44.78	6.45	HGL Too High!
P3	DI14	DI13	1.00	44.76	44.76	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	44.77	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	43.40	43.40	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	44.76	6.58	HGL Too High!
P2	DI2	DI1	1.00	43.28	43.28	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	43.28	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	43.27	43.27	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	43.28	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	44.58	44.58	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	44.59	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	44.58	44.58	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	45.36	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	42.30	42.30	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	44.58	8.13	HGL Too High!
P42	DI31	MH22	1.00	35.38	35.38	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	35.43	5.12	HGL Too High!
P43	MH22	DI32	1.00	35.35	35.35	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	35.38	5.45	HGL Too High!
P44	DI32	EX	1.00	34.71	34.71	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	35.35	5.23	HGL Too High!
P46	DI34	DI33	1.00	35.43	35.43	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	35.43	5.47	HGL Too High!
P45	DI33	DI32	1.00	35.35	35.35	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	35.43	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	19.85	19.85	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	19.85	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	42.59	42.59	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	42.71	3.63	HGL Too High!
P48	DI40	DI41	0.80	42.59	42.59	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	42.60	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	42.30	42.30	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	42.59	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	18.34	18.34	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.34	7.41	
P5	MH1	MH2	1.20	18.33	18.33	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	18.34	7.93	HGL Too High!
P7	MH2	MH3	1.20	18.32	18.32	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	18.33	7.65	HGL Too High!
P10	MH3	MH4	1.20	18.29	18.29	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	18.32	7.28	HGL Too High!
P13	MH4	MH5	1.20	18.18	18.18	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	18.29	7.09	HGL Too High!
P15	MH5	MH20	1.60	18.05	18.05	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	18.18	7.40	HGL Too High!
P6	DI16	MH2	1.00	18.33	18.33	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.33	7.33	HGL Too High!
P9	DI3	MH3	1.00	18.32	18.32	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.32	6.62	HGL Too High!
P8	DI17	MH3	1.00	18.32	18.32	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.32	6.96	HGL Too High!
P12	DI4	MH4	1.00	18.29	18.29	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.29	6.48	HGL Too High!
P11	DI18	MH4	1.00	18.29	18.29	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.29	6.56	HGL Too High!
P14	DI5	MH5	1.00	18.18	18.18	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.18	6.61	HGL Too High!
P18	DI6	MH6	1.00	18.19	18.19	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.20	7.13	HGL Too High!
P16	MH6	MH5	1.20	18.18	18.18	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	18.19	7.55	HGL Too High!
P17	DI19	MH6	1.00	18.19	18.19	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.20	7.08	HGL Too High!
P32	DI23	MH12	1.00	19.57	19.57	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.57	4.24	HGL Too High!
P31	DI9	MH12	1.00	19.57	19.57	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.57	7.13	HGL Too High!
P30	MH12	MH11	1.60	19.55	19.55	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	19.57	7.48	HGL Too High!
P27	MH11	MH10	1.60	19.51	19.51	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	19.55	7.21	HGL Too High!
P25	MH10	MH9	1.60	19.49	19.49	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	19.51	7.54	HGL Too High!
P22	MH9	MH8	1.60	19.45	19.45	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	19.49	7.85	HGL Too High!
P20	MH8	MH21	1.60	19.41	19.41	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	19.45	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	19.38	19.38	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	19.41	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	19.38	19.38	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	19.41	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	19.45	19.45	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	19.48	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	19.59	19.59	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	19.77	4.78	HGL Too High!
P51	STUB	DI22	1.00	19.59	19.59	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	19.62	7.16	HGL Too High!
P28	DI22	MH11	1.00	19.55	19.55	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	19.59	6.74	HGL Too High!
P29	DI8	MH11	1.00	19.55	19.55	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.56	6.92	HGL Too High!
P26	DI21	MH10	1.00	19.51	19.51	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.51	7.23	HGL Too High!
P23	DI20	MH9	1.00	19.49	19.49	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	19.49	7.38	HGL Too High!
P24	DI7	MH9	1.00	19.49	19.49	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.49	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	44.20	44.20	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	44.21	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	44.20	44.20	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	44.21	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	44.10	44.10	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	44.20	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	43.97	43.97	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	44.10	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	43.38	43.38	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	43.97	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	43.00	43.00	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	43.38	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	35.41	35.41	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	43.00	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	29.92	29.92	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	35.41	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	20.55	20.55	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	29.92	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	19.38	19.38	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	20.55	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	18.05	18.05	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	19.38	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	17.52	17.52	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	18.05	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.42	13.42	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	17.52	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.49	10.49	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	13.42	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.00**	**9.00**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**10.49**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	45.46	45.46	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	51.18	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	45.46	45.46	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	45.48	6.45	HGL Too High!
P3	DI14	DI13	1.00	45.46	45.46	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	45.47	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	44.10	44.10	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	45.46	6.58	HGL Too High!
P2	DI2	DI1	1.00	43.98	43.98	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	43.98	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	43.97	43.97	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	43.98	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	45.28	45.28	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	45.29	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	45.28	45.28	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	46.06	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	43.00	43.00	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	45.28	8.13	HGL Too High!
P42	DI31	MH22	1.00	36.08	36.08	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	36.13	5.12	HGL Too High!
P43	MH22	DI32	1.00	36.05	36.05	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	36.08	5.45	HGL Too High!
P44	DI32	EX	1.00	35.41	35.41	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	36.05	5.23	HGL Too High!
P46	DI34	DI33	1.00	36.13	36.13	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	36.13	5.47	HGL Too High!
P45	DI33	DI32	1.00	36.05	36.05	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	36.13	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	20.55	20.55	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	20.55	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	43.29	43.29	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	43.41	3.63	HGL Too High!
P48	DI40	DI41	0.80	43.29	43.29	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	43.30	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	43.00	43.00	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	43.29	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	18.84	18.84	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.84	7.41	
P5	MH1	MH2	1.20	18.83	18.83	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	18.84	7.93	HGL Too High!
P7	MH2	MH3	1.20	18.82	18.82	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	18.83	7.65	HGL Too High!
P10	MH3	MH4	1.20	18.79	18.79	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	18.82	7.28	HGL Too High!
P13	MH4	MH5	1.20	18.68	18.68	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	18.79	7.09	HGL Too High!
P15	MH5	MH20	1.60	18.55	18.55	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	18.68	7.40	HGL Too High!
P6	DI16	MH2	1.00	18.83	18.83	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.83	7.33	HGL Too High!
P9	DI3	MH3	1.00	18.82	18.82	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.82	6.62	HGL Too High!
P8	DI17	MH3	1.00	18.82	18.82	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.82	6.96	HGL Too High!
P12	DI4	MH4	1.00	18.79	18.79	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.79	6.48	HGL Too High!
P11	DI18	MH4	1.00	18.79	18.79	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.79	6.56	HGL Too High!
P14	DI5	MH5	1.00	18.68	18.68	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.68	6.61	HGL Too High!
P18	DI6	MH6	1.00	18.69	18.69	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.70	7.13	HGL Too High!
P16	MH6	MH5	1.20	18.68	18.68	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	18.69	7.55	HGL Too High!
P17	DI19	MH6	1.00	18.69	18.69	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.70	7.08	HGL Too High!
P32	DI23	MH12	1.00	20.07	20.07	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.07	4.24	HGL Too High!
P31	DI9	MH12	1.00	20.07	20.07	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.07	7.13	HGL Too High!
P30	MH12	MH11	1.60	20.05	20.05	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	20.07	7.48	HGL Too High!
P27	MH11	MH10	1.60	20.01	20.01	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	20.05	7.21	HGL Too High!
P25	MH10	MH9	1.60	19.99	19.99	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	20.01	7.54	HGL Too High!
P22	MH9	MH8	1.60	19.95	19.95	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	19.99	7.85	HGL Too High!
P20	MH8	MH21	1.60	19.91	19.91	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	19.95	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	19.88	19.88	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	19.91	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	19.88	19.88	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	19.91	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	19.95	19.95	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	19.98	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	20.09	20.09	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	20.27	4.78	HGL Too High!
P51	STUB	DI22	1.00	20.09	20.09	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	20.12	7.16	HGL Too High!
P28	DI22	MH11	1.00	20.05	20.05	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	20.09	6.74	HGL Too High!
P29	DI8	MH11	1.00	20.05	20.05	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.06	6.92	HGL Too High!
P26	DI21	MH10	1.00	20.01	20.01	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.01	7.23	HGL Too High!
P23	DI20	MH9	1.00	19.99	19.99	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	19.99	7.38	HGL Too High!
P24	DI7	MH9	1.00	19.99	19.99	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.99	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	44.70	44.70	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	44.71	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	44.70	44.70	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	44.71	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	44.60	44.60	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	44.70	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	44.47	44.47	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	44.60	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	43.88	43.88	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	44.47	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	43.50	43.50	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	43.88	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	35.91	35.91	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	43.50	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	30.42	30.42	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	35.91	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	21.05	21.05	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	30.42	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	19.88	19.88	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	21.05	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	18.55	18.55	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	19.88	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	18.02	18.02	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	18.55	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.92	13.92	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	18.02	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.99	10.99	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	13.92	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.50**	**9.50**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**10.99**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	45.96	45.96	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	51.68	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	45.96	45.96	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	45.98	6.45	HGL Too High!
P3	DI14	DI13	1.00	45.96	45.96	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	45.97	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	44.60	44.60	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	45.96	6.58	HGL Too High!
P2	DI2	DI1	1.00	44.48	44.48	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	44.48	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	44.47	44.47	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	44.48	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	45.78	45.78	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	45.79	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	45.78	45.78	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	46.56	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	43.50	43.50	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	45.78	8.13	HGL Too High!
P42	DI31	MH22	1.00	36.58	36.58	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	36.63	5.12	HGL Too High!
P43	MH22	DI32	1.00	36.55	36.55	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	36.58	5.45	HGL Too High!
P44	DI32	EX	1.00	35.91	35.91	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	36.55	5.23	HGL Too High!
P46	DI34	DI33	1.00	36.63	36.63	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	36.63	5.47	HGL Too High!
P45	DI33	DI32	1.00	36.55	36.55	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	36.63	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	21.05	21.05	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	21.05	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	43.79	43.79	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	43.91	3.63	HGL Too High!
P48	DI40	DI41	0.80	43.79	43.79	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	43.80	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	43.50	43.50	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	43.79	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	20.14	20.14	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.14	7.41	
P5	MH1	MH2	1.20	20.13	20.13	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	20.14	7.93	HGL Too High!
P7	MH2	MH3	1.20	20.12	20.12	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	20.13	7.65	HGL Too High!
P10	MH3	MH4	1.20	20.09	20.09	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	20.12	7.28	HGL Too High!
P13	MH4	MH5	1.20	19.98	19.98	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	20.09	7.09	HGL Too High!
P15	MH5	MH20	1.60	19.85	19.85	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	19.98	7.40	HGL Too High!
P6	DI16	MH2	1.00	20.13	20.13	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.13	7.33	HGL Too High!
P9	DI3	MH3	1.00	20.12	20.12	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.12	6.62	HGL Too High!
P8	DI17	MH3	1.00	20.12	20.12	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.12	6.96	HGL Too High!
P12	DI4	MH4	1.00	20.09	20.09	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.09	6.48	HGL Too High!
P11	DI18	MH4	1.00	20.09	20.09	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.09	6.56	HGL Too High!
P14	DI5	MH5	1.00	19.98	19.98	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.98	6.61	HGL Too High!
P18	DI6	MH6	1.00	19.99	19.99	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.00	7.13	HGL Too High!
P16	MH6	MH5	1.20	19.98	19.98	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	19.99	7.55	HGL Too High!
P17	DI19	MH6	1.00	19.99	19.99	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.00	7.08	HGL Too High!
P32	DI23	MH12	1.00	21.37	21.37	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.37	4.24	HGL Too High!
P31	DI9	MH12	1.00	21.37	21.37	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.37	7.13	HGL Too High!
P30	MH12	MH11	1.60	21.35	21.35	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	21.37	7.48	HGL Too High!
P27	MH11	MH10	1.60	21.31	21.31	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	21.35	7.21	HGL Too High!
P25	MH10	MH9	1.60	21.29	21.29	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	21.31	7.54	HGL Too High!
P22	MH9	MH8	1.60	21.25	21.25	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	21.29	7.85	HGL Too High!
P20	MH8	MH21	1.60	21.21	21.21	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	21.25	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	21.18	21.18	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	21.21	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	21.18	21.18	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	21.21	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	21.25	21.25	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	21.28	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	21.39	21.39	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	21.57	4.78	HGL Too High!
P51	STUB	DI22	1.00	21.39	21.39	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	21.42	7.16	HGL Too High!
P28	DI22	MH11	1.00	21.35	21.35	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	21.39	6.74	HGL Too High!
P29	DI8	MH11	1.00	21.35	21.35	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.36	6.92	HGL Too High!
P26	DI21	MH10	1.00	21.31	21.31	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.31	7.23	HGL Too High!
P23	DI20	MH9	1.00	21.29	21.29	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	21.29	7.38	HGL Too High!
P24	DI7	MH9	1.00	21.29	21.29	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.29	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	46.00	46.00	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	46.01	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	46.00	46.00	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	46.01	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	45.90	45.90	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	46.00	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	45.77	45.77	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	45.90	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	45.18	45.18	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	45.77	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	44.80	44.80	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	45.18	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	37.21	37.21	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	44.80	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	31.72	31.72	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	37.21	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	22.35	22.35	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	31.72	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	21.18	21.18	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	22.35	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	19.85	19.85	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	21.18	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	19.32	19.32	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	19.85	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.22	15.22	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	19.32	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.29	12.29	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	15.22	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.80**	**10.80**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**12.29**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	47.26	47.26	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	52.98	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	47.26	47.26	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	47.28	6.45	HGL Too High!
P3	DI14	DI13	1.00	47.26	47.26	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	47.27	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	45.90	45.90	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	47.26	6.58	HGL Too High!
P2	DI2	DI1	1.00	45.78	45.78	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	45.78	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	45.77	45.77	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	45.78	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	47.08	47.08	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	47.09	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	47.08	47.08	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	47.86	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	44.80	44.80	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	47.08	8.13	HGL Too High!
P42	DI31	MH22	1.00	37.88	37.88	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	37.93	5.12	HGL Too High!
P43	MH22	DI32	1.00	37.85	37.85	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	37.88	5.45	HGL Too High!
P44	DI32	EX	1.00	37.21	37.21	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	37.85	5.23	HGL Too High!
P46	DI34	DI33	1.00	37.93	37.93	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	37.93	5.47	HGL Too High!
P45	DI33	DI32	1.00	37.85	37.85	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	37.93	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	22.35	22.35	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	22.35	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	45.09	45.09	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	45.21	3.63	HGL Too High!
P48	DI40	DI41	0.80	45.09	45.09	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	45.10	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	44.80	44.80	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	45.09	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	15.08	15.08	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.08	7.41	
P5	MH1	MH2	1.20	15.07	15.07	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	15.08	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.06	15.06	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	15.07	7.65	HGL Too High!
P10	MH3	MH4	1.20	15.03	15.03	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	15.06	7.28	HGL Too High!
P13	MH4	MH5	1.20	14.92	14.92	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	15.03	7.09	HGL Too High!
P15	MH5	MH20	1.60	14.79	14.79	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	14.92	7.40	HGL Too High!
P6	DI16	MH2	1.00	15.07	15.07	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.07	7.33	HGL Too High!
P9	DI3	MH3	1.00	15.06	15.06	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.06	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.06	15.06	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.06	6.96	HGL Too High!
P12	DI4	MH4	1.00	15.03	15.03	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.03	6.48	HGL Too High!
P11	DI18	MH4	1.00	15.03	15.03	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.03	6.56	HGL Too High!
P14	DI5	MH5	1.00	14.92	14.92	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.92	6.61	HGL Too High!
P18	DI6	MH6	1.00	14.93	14.93	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	14.94	7.13	HGL Too High!
P16	MH6	MH5	1.20	14.92	14.92	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	14.93	7.55	HGL Too High!
P17	DI19	MH6	1.00	14.93	14.93	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	14.94	7.08	HGL Too High!
P32	DI23	MH12	1.00	16.31	16.31	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.31	4.24	HGL Too High!
P31	DI9	MH12	1.00	16.31	16.31	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.31	7.13	HGL Too High!
P30	MH12	MH11	1.60	16.29	16.29	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	16.31	7.48	HGL Too High!
P27	MH11	MH10	1.60	16.25	16.25	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	16.29	7.21	HGL Too High!
P25	MH10	MH9	1.60	16.23	16.23	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	16.25	7.54	HGL Too High!
P22	MH9	MH8	1.60	16.19	16.19	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	16.23	7.85	HGL Too High!
P20	MH8	MH21	1.60	16.15	16.15	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	16.19	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	16.12	16.12	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	16.15	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	16.12	16.12	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	16.15	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	16.19	16.19	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	16.22	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	16.33	16.33	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	16.51	4.78	HGL Too High!
P51	STUB	DI22	1.00	16.33	16.33	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	16.36	7.16	HGL Too High!
P28	DI22	MH11	1.00	16.29	16.29	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	16.33	6.74	HGL Too High!
P29	DI8	MH11	1.00	16.29	16.29	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.30	6.92	HGL Too High!
P26	DI21	MH10	1.00	16.25	16.25	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.25	7.23	HGL Too High!
P23	DI20	MH9	1.00	16.23	16.23	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	16.23	7.38	HGL Too High!
P24	DI7	MH9	1.00	16.23	16.23	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.23	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	40.94	40.94	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	40.95	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	40.94	40.94	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	40.95	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	40.84	40.84	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	40.94	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	40.71	40.71	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	40.84	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	40.12	40.12	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	40.71	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	39.74	39.74	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	40.12	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	32.15	32.15	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	39.74	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	26.66	26.66	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	32.15	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	17.29	17.29	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	26.66	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	16.12	16.12	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	17.29	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	14.79	14.79	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	16.12	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	14.26	14.26	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	14.79	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	10.16	10.16	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	14.26	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	7.23	7.23	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	10.16	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.74**	**5.74**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**7.23**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	42.20	42.20	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	47.92	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	42.20	42.20	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	42.22	6.45	HGL Too High!
P3	DI14	DI13	1.00	42.20	42.20	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	42.21	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	40.84	40.84	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	42.20	6.58	HGL Too High!
P2	DI2	DI1	1.00	40.72	40.72	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	40.72	6.84	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	40.71	40.71	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	40.72	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	42.02	42.02	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	42.03	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	42.02	42.02	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	42.80	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	39.74	39.74	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	42.02	8.13	HGL Too High!
P42	DI31	MH22	1.00	32.82	32.82	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	32.87	5.12	HGL Too High!
P43	MH22	DI32	1.00	32.79	32.79	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	32.82	5.45	HGL Too High!
P44	DI32	EX	1.00	32.15	32.15	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	32.79	5.23	HGL Too High!
P46	DI34	DI33	1.00	32.87	32.87	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.87	5.47	HGL Too High!
P45	DI33	DI32	1.00	32.79	32.79	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	32.87	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	17.29	17.29	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	17.29	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	40.03	40.03	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	40.15	3.63	HGL Too High!
P48	DI40	DI41	0.80	40.03	40.03	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	40.04	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	39.74	39.74	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	40.03	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	15.28	15.28	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.28	7.41	
P5	MH1	MH2	1.20	15.27	15.27	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	15.28	7.93	HGL Too High!
P7	MH2	MH3	1.20	15.26	15.26	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	15.27	7.65	HGL Too High!
P10	MH3	MH4	1.20	15.23	15.23	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	15.26	7.28	HGL Too High!
P13	MH4	MH5	1.20	15.12	15.12	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	15.23	7.09	HGL Too High!
P15	MH5	MH20	1.60	14.99	14.99	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	15.12	7.40	HGL Too High!
P6	DI16	MH2	1.00	15.27	15.27	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.27	7.33	HGL Too High!
P9	DI3	MH3	1.00	15.26	15.26	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.26	6.62	HGL Too High!
P8	DI17	MH3	1.00	15.26	15.26	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.26	6.96	HGL Too High!
P12	DI4	MH4	1.00	15.23	15.23	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.23	6.48	HGL Too High!
P11	DI18	MH4	1.00	15.23	15.23	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.23	6.56	HGL Too High!
P14	DI5	MH5	1.00	15.12	15.12	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.12	6.61	HGL Too High!
P18	DI6	MH6	1.00	15.13	15.13	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	15.14	7.13	HGL Too High!
P16	MH6	MH5	1.20	15.12	15.12	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	15.13	7.55	HGL Too High!
P17	DI19	MH6	1.00	15.13	15.13	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	15.14	7.08	HGL Too High!
P32	DI23	MH12	1.00	16.51	16.51	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.51	4.24	HGL Too High!
P31	DI9	MH12	1.00	16.51	16.51	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.51	7.13	HGL Too High!
P30	MH12	MH11	1.60	16.49	16.49	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	16.51	7.48	HGL Too High!
P27	MH11	MH10	1.60	16.45	16.45	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	16.49	7.21	HGL Too High!
P25	MH10	MH9	1.60	16.43	16.43	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	16.45	7.54	HGL Too High!
P22	MH9	MH8	1.60	16.39	16.39	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	16.43	7.85	HGL Too High!
P20	MH8	MH21	1.60	16.35	16.35	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	16.39	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	16.32	16.32	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	16.35	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	16.32	16.32	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	16.35	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	16.39	16.39	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	16.42	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	16.53	16.53	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	16.71	4.78	HGL Too High!
P51	STUB	DI22	1.00	16.53	16.53	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	16.56	7.16	HGL Too High!
P28	DI22	MH11	1.00	16.49	16.49	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	16.53	6.74	HGL Too High!
P29	DI8	MH11	1.00	16.49	16.49	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.50	6.92	HGL Too High!
P26	DI21	MH10	1.00	16.45	16.45	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.45	7.23	HGL Too High!
P23	DI20	MH9	1.00	16.43	16.43	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	16.43	7.38	HGL Too High!
P24	DI7	MH9	1.00	16.43	16.43	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.43	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	41.14	41.14	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	41.15	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	41.14	41.14	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	41.15	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	41.04	41.04	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	41.14	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	40.91	40.91	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	41.04	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	40.32	40.32	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	40.91	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	39.94	39.94	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	40.32	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	32.35	32.35	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	39.94	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	26.86	26.86	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	32.35	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	17.49	17.49	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	26.86	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	16.32	16.32	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	17.49	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	14.99	14.99	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	16.32	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	14.46	14.46	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	14.99	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	10.36	10.36	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	14.46	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	7.43	7.43	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	10.36	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.94**	**5.94**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**7.43**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	42.40	42.40	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	48.12	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	42.40	42.40	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	42.42	6.45	HGL Too High!
P3	DI14	DI13	1.00	42.40	42.40	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	42.41	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	41.04	41.04	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	42.40	6.58	HGL Too High!
P2	DI2	DI1	1.00	40.92	40.92	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	40.92	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	40.91	40.91	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	40.92	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	42.22	42.22	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	42.23	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	42.22	42.22	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	43.00	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	39.94	39.94	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	42.22	8.13	HGL Too High!
P42	DI31	MH22	1.00	33.02	33.02	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	33.07	5.12	HGL Too High!
P43	MH22	DI32	1.00	32.99	32.99	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	33.02	5.45	HGL Too High!
P44	DI32	EX	1.00	32.35	32.35	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	32.99	5.23	HGL Too High!
P46	DI34	DI33	1.00	33.07	33.07	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.07	5.47	HGL Too High!
P45	DI33	DI32	1.00	32.99	32.99	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	33.07	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	17.49	17.49	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	17.49	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	40.23	40.23	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	40.35	3.63	HGL Too High!
P48	DI40	DI41	0.80	40.23	40.23	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	40.24	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	39.94	39.94	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	40.23	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	18.78	18.78	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.78	7.41	
P5	MH1	MH2	1.20	18.77	18.77	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	18.78	7.93	HGL Too High!
P7	MH2	MH3	1.20	18.76	18.76	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	18.77	7.65	HGL Too High!
P10	MH3	MH4	1.20	18.73	18.73	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	18.76	7.28	HGL Too High!
P13	MH4	MH5	1.20	18.62	18.62	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	18.73	7.09	HGL Too High!
P15	MH5	MH20	1.60	18.49	18.49	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	18.62	7.40	HGL Too High!
P6	DI16	MH2	1.00	18.77	18.77	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.77	7.33	HGL Too High!
P9	DI3	MH3	1.00	18.76	18.76	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.76	6.62	HGL Too High!
P8	DI17	MH3	1.00	18.76	18.76	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.76	6.96	HGL Too High!
P12	DI4	MH4	1.00	18.73	18.73	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.73	6.48	HGL Too High!
P11	DI18	MH4	1.00	18.73	18.73	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.73	6.56	HGL Too High!
P14	DI5	MH5	1.00	18.62	18.62	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.62	6.61	HGL Too High!
P18	DI6	MH6	1.00	18.63	18.63	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.64	7.13	HGL Too High!
P16	MH6	MH5	1.20	18.62	18.62	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	18.63	7.55	HGL Too High!
P17	DI19	MH6	1.00	18.63	18.63	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.64	7.08	HGL Too High!
P32	DI23	MH12	1.00	20.01	20.01	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.01	4.24	HGL Too High!
P31	DI9	MH12	1.00	20.01	20.01	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.01	7.13	HGL Too High!
P30	MH12	MH11	1.60	19.99	19.99	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	20.01	7.48	HGL Too High!
P27	MH11	MH10	1.60	19.95	19.95	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	19.99	7.21	HGL Too High!
P25	MH10	MH9	1.60	19.93	19.93	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	19.95	7.54	HGL Too High!
P22	MH9	MH8	1.60	19.89	19.89	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	19.93	7.85	HGL Too High!
P20	MH8	MH21	1.60	19.85	19.85	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	19.89	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	19.82	19.82	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	19.85	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	19.82	19.82	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	19.85	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	19.89	19.89	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	19.92	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	20.03	20.03	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	20.21	4.78	HGL Too High!
P51	STUB	DI22	1.00	20.03	20.03	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	20.06	7.16	HGL Too High!
P28	DI22	MH11	1.00	19.99	19.99	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	20.03	6.74	HGL Too High!
P29	DI8	MH11	1.00	19.99	19.99	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.00	6.92	HGL Too High!
P26	DI21	MH10	1.00	19.95	19.95	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.95	7.23	HGL Too High!
P23	DI20	MH9	1.00	19.93	19.93	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	19.93	7.38	HGL Too High!
P24	DI7	MH9	1.00	19.93	19.93	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.93	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	44.64	44.64	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	44.65	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	44.64	44.64	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	44.65	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	44.54	44.54	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	44.64	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	44.41	44.41	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	44.54	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	43.82	43.82	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	44.41	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	43.44	43.44	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	43.82	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	35.85	35.85	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	43.44	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	30.36	30.36	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	35.85	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	20.99	20.99	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	30.36	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	19.82	19.82	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	20.99	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	18.49	18.49	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	19.82	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	17.96	17.96	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	18.49	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.86	13.86	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	17.96	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.93	10.93	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	13.86	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.44**	**9.44**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**10.93**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	45.90	45.90	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	51.62	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	45.90	45.90	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	45.92	6.45	HGL Too High!
P3	DI14	DI13	1.00	45.90	45.90	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	45.91	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	44.54	44.54	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	45.90	6.58	HGL Too High!
P2	DI2	DI1	1.00	44.42	44.42	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	44.42	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	44.41	44.41	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	44.42	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	45.72	45.72	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	45.73	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	45.72	45.72	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	46.50	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	43.44	43.44	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	45.72	8.13	HGL Too High!
P42	DI31	MH22	1.00	36.52	36.52	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	36.57	5.12	HGL Too High!
P43	MH22	DI32	1.00	36.49	36.49	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	36.52	5.45	HGL Too High!
P44	DI32	EX	1.00	35.85	35.85	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	36.49	5.23	HGL Too High!
P46	DI34	DI33	1.00	36.57	36.57	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	36.57	5.47	HGL Too High!
P45	DI33	DI32	1.00	36.49	36.49	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	36.57	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	20.99	20.99	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	20.99	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	43.73	43.73	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	43.85	3.63	HGL Too High!
P48	DI40	DI41	0.80	43.73	43.73	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	43.74	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	43.44	43.44	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	43.73	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	19.28	19.28	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.28	7.41	
P5	MH1	MH2	1.20	19.27	19.27	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	19.28	7.93	HGL Too High!
P7	MH2	MH3	1.20	19.26	19.26	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	19.27	7.65	HGL Too High!
P10	MH3	MH4	1.20	19.23	19.23	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	19.26	7.28	HGL Too High!
P13	MH4	MH5	1.20	19.12	19.12	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	19.23	7.09	HGL Too High!
P15	MH5	MH20	1.60	18.99	18.99	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	19.12	7.40	HGL Too High!
P6	DI16	MH2	1.00	19.27	19.27	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.27	7.33	HGL Too High!
P9	DI3	MH3	1.00	19.26	19.26	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.26	6.62	HGL Too High!
P8	DI17	MH3	1.00	19.26	19.26	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.26	6.96	HGL Too High!
P12	DI4	MH4	1.00	19.23	19.23	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.23	6.48	HGL Too High!
P11	DI18	MH4	1.00	19.23	19.23	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.23	6.56	HGL Too High!
P14	DI5	MH5	1.00	19.12	19.12	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.12	6.61	HGL Too High!
P18	DI6	MH6	1.00	19.13	19.13	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.14	7.13	HGL Too High!
P16	MH6	MH5	1.20	19.12	19.12	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	19.13	7.55	HGL Too High!
P17	DI19	MH6	1.00	19.13	19.13	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.14	7.08	HGL Too High!
P32	DI23	MH12	1.00	20.51	20.51	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.51	4.24	HGL Too High!
P31	DI9	MH12	1.00	20.51	20.51	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.51	7.13	HGL Too High!
P30	MH12	MH11	1.60	20.49	20.49	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	20.51	7.48	HGL Too High!
P27	MH11	MH10	1.60	20.45	20.45	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	20.49	7.21	HGL Too High!
P25	MH10	MH9	1.60	20.43	20.43	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	20.45	7.54	HGL Too High!
P22	MH9	MH8	1.60	20.39	20.39	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	20.43	7.85	HGL Too High!
P20	MH8	MH21	1.60	20.35	20.35	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	20.39	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	20.32	20.32	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	20.35	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	20.32	20.32	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	20.35	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	20.39	20.39	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	20.42	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	20.53	20.53	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	20.71	4.78	HGL Too High!
P51	STUB	DI22	1.00	20.53	20.53	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	20.56	7.16	HGL Too High!
P28	DI22	MH11	1.00	20.49	20.49	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	20.53	6.74	HGL Too High!
P29	DI8	MH11	1.00	20.49	20.49	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.50	6.92	HGL Too High!
P26	DI21	MH10	1.00	20.45	20.45	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.45	7.23	HGL Too High!
P23	DI20	MH9	1.00	20.43	20.43	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	20.43	7.38	HGL Too High!
P24	DI7	MH9	1.00	20.43	20.43	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.43	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	45.14	45.14	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	45.15	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	45.14	45.14	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	45.15	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	45.04	45.04	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	45.14	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	44.91	44.91	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	45.04	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	44.32	44.32	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	44.91	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	43.94	43.94	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	44.32	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	36.35	36.35	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	43.94	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	30.86	30.86	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	36.35	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	21.49	21.49	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	30.86	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	20.32	20.32	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	21.49	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	18.99	18.99	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	20.32	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	18.46	18.46	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	18.99	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	14.36	14.36	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	18.46	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.43	11.43	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	14.36	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.94**	**9.94**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**11.43**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	46.40	46.40	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	52.12	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	46.40	46.40	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	46.42	6.45	HGL Too High!
P3	DI14	DI13	1.00	46.40	46.40	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	46.41	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	45.04	45.04	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	46.40	6.58	HGL Too High!
P2	DI2	DI1	1.00	44.92	44.92	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	44.92	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	44.91	44.91	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	44.92	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	46.22	46.22	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	46.23	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	46.22	46.22	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	47.00	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	43.94	43.94	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	46.22	8.13	HGL Too High!
P42	DI31	MH22	1.00	37.02	37.02	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	37.07	5.12	HGL Too High!
P43	MH22	DI32	1.00	36.99	36.99	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	37.02	5.45	HGL Too High!
P44	DI32	EX	1.00	36.35	36.35	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	36.99	5.23	HGL Too High!
P46	DI34	DI33	1.00	37.07	37.07	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	37.07	5.47	HGL Too High!
P45	DI33	DI32	1.00	36.99	36.99	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	37.07	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	21.49	21.49	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	21.49	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	44.23	44.23	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	44.35	3.63	HGL Too High!
P48	DI40	DI41	0.80	44.23	44.23	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	44.24	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	43.94	43.94	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	44.23	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	19.68	19.68	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.68	7.41	
P5	MH1	MH2	1.20	19.67	19.67	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	19.68	7.93	HGL Too High!
P7	MH2	MH3	1.20	19.66	19.66	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	19.67	7.65	HGL Too High!
P10	MH3	MH4	1.20	19.63	19.63	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	19.66	7.28	HGL Too High!
P13	MH4	MH5	1.20	19.52	19.52	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	19.63	7.09	HGL Too High!
P15	MH5	MH20	1.60	19.39	19.39	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	19.52	7.40	HGL Too High!
P6	DI16	MH2	1.00	19.67	19.67	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.67	7.33	HGL Too High!
P9	DI3	MH3	1.00	19.66	19.66	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.66	6.62	HGL Too High!
P8	DI17	MH3	1.00	19.66	19.66	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.66	6.96	HGL Too High!
P12	DI4	MH4	1.00	19.63	19.63	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.63	6.48	HGL Too High!
P11	DI18	MH4	1.00	19.63	19.63	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.63	6.56	HGL Too High!
P14	DI5	MH5	1.00	19.52	19.52	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.52	6.61	HGL Too High!
P18	DI6	MH6	1.00	19.53	19.53	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.54	7.13	HGL Too High!
P16	MH6	MH5	1.20	19.52	19.52	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	19.53	7.55	HGL Too High!
P17	DI19	MH6	1.00	19.53	19.53	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.54	7.08	HGL Too High!
P32	DI23	MH12	1.00	20.91	20.91	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.91	4.24	HGL Too High!
P31	DI9	MH12	1.00	20.91	20.91	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.91	7.13	HGL Too High!
P30	MH12	MH11	1.60	20.89	20.89	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	20.91	7.48	HGL Too High!
P27	MH11	MH10	1.60	20.85	20.85	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	20.89	7.21	HGL Too High!
P25	MH10	MH9	1.60	20.83	20.83	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	20.85	7.54	HGL Too High!
P22	MH9	MH8	1.60	20.79	20.79	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	20.83	7.85	HGL Too High!
P20	MH8	MH21	1.60	20.75	20.75	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	20.79	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	20.72	20.72	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	20.75	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	20.72	20.72	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	20.75	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	20.79	20.79	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	20.82	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	20.93	20.93	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	21.11	4.78	HGL Too High!
P51	STUB	DI22	1.00	20.93	20.93	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	20.96	7.16	HGL Too High!
P28	DI22	MH11	1.00	20.89	20.89	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	20.93	6.74	HGL Too High!
P29	DI8	MH11	1.00	20.89	20.89	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.90	6.92	HGL Too High!
P26	DI21	MH10	1.00	20.85	20.85	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.85	7.23	HGL Too High!
P23	DI20	MH9	1.00	20.83	20.83	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	20.83	7.38	HGL Too High!
P24	DI7	MH9	1.00	20.83	20.83	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.83	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	45.54	45.54	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	45.55	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	45.54	45.54	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	45.55	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	45.44	45.44	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	45.54	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	45.31	45.31	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	45.44	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	44.72	44.72	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	45.31	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	44.34	44.34	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	44.72	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	36.75	36.75	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	44.34	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	31.26	31.26	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	36.75	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	21.89	21.89	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	31.26	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	20.72	20.72	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	21.89	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	19.39	19.39	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	20.72	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	18.86	18.86	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	19.39	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	14.76	14.76	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	18.86	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.83	11.83	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	14.76	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.34**	**10.34**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**11.83**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	46.80	46.80	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	52.52	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	46.80	46.80	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	46.82	6.45	HGL Too High!
P3	DI14	DI13	1.00	46.80	46.80	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	46.81	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	45.44	45.44	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	46.80	6.58	HGL Too High!
P2	DI2	DI1	1.00	45.32	45.32	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	45.32	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	45.31	45.31	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	45.32	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	46.62	46.62	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	46.63	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	46.62	46.62	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	47.40	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	44.34	44.34	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	46.62	8.13	HGL Too High!
P42	DI31	MH22	1.00	37.42	37.42	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	37.47	5.12	HGL Too High!
P43	MH22	DI32	1.00	37.39	37.39	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	37.42	5.45	HGL Too High!
P44	DI32	EX	1.00	36.75	36.75	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	37.39	5.23	HGL Too High!
P46	DI34	DI33	1.00	37.47	37.47	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	37.47	5.47	HGL Too High!
P45	DI33	DI32	1.00	37.39	37.39	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	37.47	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	21.89	21.89	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	21.89	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	44.63	44.63	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	44.75	3.63	HGL Too High!
P48	DI40	DI41	0.80	44.63	44.63	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	44.64	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	44.34	44.34	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	44.63	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	20.18	20.18	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.18	7.41	
P5	MH1	MH2	1.20	20.17	20.17	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	20.18	7.93	HGL Too High!
P7	MH2	MH3	1.20	20.16	20.16	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	20.17	7.65	HGL Too High!
P10	MH3	MH4	1.20	20.13	20.13	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	20.16	7.28	HGL Too High!
P13	MH4	MH5	1.20	20.02	20.02	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	20.13	7.09	HGL Too High!
P15	MH5	MH20	1.60	19.89	19.89	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	20.02	7.40	HGL Too High!
P6	DI16	MH2	1.00	20.17	20.17	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.17	7.33	HGL Too High!
P9	DI3	MH3	1.00	20.16	20.16	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.16	6.62	HGL Too High!
P8	DI17	MH3	1.00	20.16	20.16	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.16	6.96	HGL Too High!
P12	DI4	MH4	1.00	20.13	20.13	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.13	6.48	HGL Too High!
P11	DI18	MH4	1.00	20.13	20.13	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.13	6.56	HGL Too High!
P14	DI5	MH5	1.00	20.02	20.02	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.02	6.61	HGL Too High!
P18	DI6	MH6	1.00	20.03	20.03	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.04	7.13	HGL Too High!
P16	MH6	MH5	1.20	20.02	20.02	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	20.03	7.55	HGL Too High!
P17	DI19	MH6	1.00	20.03	20.03	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.04	7.08	HGL Too High!
P32	DI23	MH12	1.00	21.41	21.41	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.41	4.24	HGL Too High!
P31	DI9	MH12	1.00	21.41	21.41	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.41	7.13	HGL Too High!
P30	MH12	MH11	1.60	21.39	21.39	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	21.41	7.48	HGL Too High!
P27	MH11	MH10	1.60	21.35	21.35	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	21.39	7.21	HGL Too High!
P25	MH10	MH9	1.60	21.33	21.33	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	21.35	7.54	HGL Too High!
P22	MH9	MH8	1.60	21.29	21.29	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	21.33	7.85	HGL Too High!
P20	MH8	MH21	1.60	21.25	21.25	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	21.29	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	21.22	21.22	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	21.25	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	21.22	21.22	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	21.25	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	21.29	21.29	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	21.32	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	21.43	21.43	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	21.61	4.78	HGL Too High!
P51	STUB	DI22	1.00	21.43	21.43	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	21.46	7.16	HGL Too High!
P28	DI22	MH11	1.00	21.39	21.39	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	21.43	6.74	HGL Too High!
P29	DI8	MH11	1.00	21.39	21.39	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.40	6.92	HGL Too High!
P26	DI21	MH10	1.00	21.35	21.35	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.35	7.23	HGL Too High!
P23	DI20	MH9	1.00	21.33	21.33	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	21.33	7.38	HGL Too High!
P24	DI7	MH9	1.00	21.33	21.33	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.33	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	46.04	46.04	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	46.05	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	46.04	46.04	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	46.05	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	45.94	45.94	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	46.04	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	45.81	45.81	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	45.94	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	45.22	45.22	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	45.81	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	44.84	44.84	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	45.22	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	37.25	37.25	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	44.84	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	31.76	31.76	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	37.25	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	22.39	22.39	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	31.76	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	21.22	21.22	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	22.39	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	19.89	19.89	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	21.22	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	19.36	19.36	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	19.89	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.26	15.26	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	19.36	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.33	12.33	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	15.26	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.84**	**10.84**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**12.33**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	47.30	47.30	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	53.02	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	47.30	47.30	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	47.32	6.45	HGL Too High!
P3	DI14	DI13	1.00	47.30	47.30	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	47.31	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	45.94	45.94	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	47.30	6.58	HGL Too High!
P2	DI2	DI1	1.00	45.82	45.82	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	45.82	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	45.81	45.81	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	45.82	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	47.12	47.12	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	47.13	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	47.12	47.12	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	47.90	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	44.84	44.84	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	47.12	8.13	HGL Too High!
P42	DI31	MH22	1.00	37.92	37.92	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	37.97	5.12	HGL Too High!
P43	MH22	DI32	1.00	37.89	37.89	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	37.92	5.45	HGL Too High!
P44	DI32	EX	1.00	37.25	37.25	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	37.89	5.23	HGL Too High!
P46	DI34	DI33	1.00	37.97	37.97	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	37.97	5.47	HGL Too High!
P45	DI33	DI32	1.00	37.89	37.89	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	37.97	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	22.39	22.39	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	22.39	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	45.13	45.13	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	45.25	3.63	HGL Too High!
P48	DI40	DI41	0.80	45.13	45.13	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	45.14	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	44.84	44.84	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	45.13	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	20.88	20.88	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.88	7.41	
P5	MH1	MH2	1.20	20.87	20.87	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	20.88	7.93	HGL Too High!
P7	MH2	MH3	1.20	20.86	20.86	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	20.87	7.65	HGL Too High!
P10	MH3	MH4	1.20	20.83	20.83	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	20.86	7.28	HGL Too High!
P13	MH4	MH5	1.20	20.72	20.72	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	20.83	7.09	HGL Too High!
P15	MH5	MH20	1.60	20.59	20.59	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	20.72	7.40	HGL Too High!
P6	DI16	MH2	1.00	20.87	20.87	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.87	7.33	HGL Too High!
P9	DI3	MH3	1.00	20.86	20.86	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.86	6.62	HGL Too High!
P8	DI17	MH3	1.00	20.86	20.86	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.86	6.96	HGL Too High!
P12	DI4	MH4	1.00	20.83	20.83	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.83	6.48	HGL Too High!
P11	DI18	MH4	1.00	20.83	20.83	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.83	6.56	HGL Too High!
P14	DI5	MH5	1.00	20.72	20.72	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.72	6.61	HGL Too High!
P18	DI6	MH6	1.00	20.73	20.73	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.74	7.13	HGL Too High!
P16	MH6	MH5	1.20	20.72	20.72	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	20.73	7.55	HGL Too High!
P17	DI19	MH6	1.00	20.73	20.73	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.74	7.08	HGL Too High!
P32	DI23	MH12	1.00	22.11	22.11	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.11	4.24	HGL Too High!
P31	DI9	MH12	1.00	22.11	22.11	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.11	7.13	HGL Too High!
P30	MH12	MH11	1.60	22.09	22.09	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	22.11	7.48	HGL Too High!
P27	MH11	MH10	1.60	22.05	22.05	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	22.09	7.21	HGL Too High!
P25	MH10	MH9	1.60	22.03	22.03	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	22.05	7.54	HGL Too High!
P22	MH9	MH8	1.60	21.99	21.99	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	22.03	7.85	HGL Too High!
P20	MH8	MH21	1.60	21.95	21.95	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	21.99	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	21.92	21.92	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	21.95	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	21.92	21.92	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	21.95	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	21.99	21.99	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	22.02	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	22.13	22.13	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	22.31	4.78	HGL Too High!
P51	STUB	DI22	1.00	22.13	22.13	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	22.16	7.16	HGL Too High!
P28	DI22	MH11	1.00	22.09	22.09	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	22.13	6.74	HGL Too High!
P29	DI8	MH11	1.00	22.09	22.09	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.10	6.92	HGL Too High!
P26	DI21	MH10	1.00	22.05	22.05	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.05	7.23	HGL Too High!
P23	DI20	MH9	1.00	22.03	22.03	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	22.03	7.38	HGL Too High!
P24	DI7	MH9	1.00	22.03	22.03	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.03	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	46.74	46.74	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	46.75	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	46.74	46.74	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	46.75	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	46.64	46.64	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	46.74	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	46.51	46.51	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	46.64	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	45.92	45.92	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	46.51	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	45.54	45.54	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	45.92	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	37.95	37.95	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	45.54	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	32.46	32.46	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	37.95	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	23.09	23.09	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	32.46	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	21.92	21.92	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	23.09	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	20.59	20.59	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	21.92	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	20.06	20.06	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	20.59	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.96	15.96	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	20.06	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.03	13.03	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	15.96	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**11.54**	**11.54**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**13.03**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	48.00	48.00	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	53.72	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	48.00	48.00	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	48.02	6.45	HGL Too High!
P3	DI14	DI13	1.00	48.00	48.00	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	48.01	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	46.64	46.64	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	48.00	6.58	HGL Too High!
P2	DI2	DI1	1.00	46.52	46.52	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	46.52	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	46.51	46.51	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	46.52	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	47.82	47.82	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	47.83	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	47.82	47.82	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	48.60	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	45.54	45.54	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	47.82	8.13	HGL Too High!
P42	DI31	MH22	1.00	38.62	38.62	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	38.67	5.12	HGL Too High!
P43	MH22	DI32	1.00	38.59	38.59	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	38.62	5.45	HGL Too High!
P44	DI32	EX	1.00	37.95	37.95	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	38.59	5.23	HGL Too High!
P46	DI34	DI33	1.00	38.67	38.67	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	38.67	5.47	HGL Too High!
P45	DI33	DI32	1.00	38.59	38.59	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	38.67	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	23.09	23.09	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	23.09	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	45.83	45.83	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	45.95	3.63	HGL Too High!
P48	DI40	DI41	0.80	45.83	45.83	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	45.84	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	45.54	45.54	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	45.83	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	21.38	21.38	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.38	7.41	
P5	MH1	MH2	1.20	21.37	21.37	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	21.38	7.93	HGL Too High!
P7	MH2	MH3	1.20	21.36	21.36	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	21.37	7.65	HGL Too High!
P10	MH3	MH4	1.20	21.33	21.33	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	21.36	7.28	HGL Too High!
P13	MH4	MH5	1.20	21.22	21.22	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	21.33	7.09	HGL Too High!
P15	MH5	MH20	1.60	21.09	21.09	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	21.22	7.40	HGL Too High!
P6	DI16	MH2	1.00	21.37	21.37	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.37	7.33	HGL Too High!
P9	DI3	MH3	1.00	21.36	21.36	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.36	6.62	HGL Too High!
P8	DI17	MH3	1.00	21.36	21.36	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.36	6.96	HGL Too High!
P12	DI4	MH4	1.00	21.33	21.33	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.33	6.48	HGL Too High!
P11	DI18	MH4	1.00	21.33	21.33	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.33	6.56	HGL Too High!
P14	DI5	MH5	1.00	21.22	21.22	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.22	6.61	HGL Too High!
P18	DI6	MH6	1.00	21.23	21.23	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.24	7.13	HGL Too High!
P16	MH6	MH5	1.20	21.22	21.22	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	21.23	7.55	HGL Too High!
P17	DI19	MH6	1.00	21.23	21.23	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.24	7.08	HGL Too High!
P32	DI23	MH12	1.00	22.61	22.61	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.61	4.24	HGL Too High!
P31	DI9	MH12	1.00	22.61	22.61	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.61	7.13	HGL Too High!
P30	MH12	MH11	1.60	22.59	22.59	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	22.61	7.48	HGL Too High!
P27	MH11	MH10	1.60	22.55	22.55	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	22.59	7.21	HGL Too High!
P25	MH10	MH9	1.60	22.53	22.53	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	22.55	7.54	HGL Too High!
P22	MH9	MH8	1.60	22.49	22.49	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	22.53	7.85	HGL Too High!
P20	MH8	MH21	1.60	22.45	22.45	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	22.49	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	22.42	22.42	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	22.45	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	22.42	22.42	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	22.45	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	22.49	22.49	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	22.52	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	22.63	22.63	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	22.81	4.78	HGL Too High!
P51	STUB	DI22	1.00	22.63	22.63	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	22.66	7.16	HGL Too High!
P28	DI22	MH11	1.00	22.59	22.59	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	22.63	6.74	HGL Too High!
P29	DI8	MH11	1.00	22.59	22.59	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.60	6.92	HGL Too High!
P26	DI21	MH10	1.00	22.55	22.55	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.55	7.23	HGL Too High!
P23	DI20	MH9	1.00	22.53	22.53	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	22.53	7.38	HGL Too High!
P24	DI7	MH9	1.00	22.53	22.53	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.53	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	47.24	47.24	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	47.25	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	47.24	47.24	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	47.25	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	47.14	47.14	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	47.24	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	47.01	47.01	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	47.14	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	46.42	46.42	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	47.01	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	46.04	46.04	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	46.42	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	38.45	38.45	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	46.04	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	32.96	32.96	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	38.45	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	23.59	23.59	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	32.96	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	22.42	22.42	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	23.59	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	21.09	21.09	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	22.42	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	20.56	20.56	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	21.09	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	16.46	16.46	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	20.56	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.53	13.53	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	16.46	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**12.04**	**12.04**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**13.53**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	48.50	48.50	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	54.22	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	48.50	48.50	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	48.52	6.45	HGL Too High!
P3	DI14	DI13	1.00	48.50	48.50	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	48.51	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	47.14	47.14	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	48.50	6.58	HGL Too High!
P2	DI2	DI1	1.00	47.02	47.02	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	47.02	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	47.01	47.01	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	47.02	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	48.32	48.32	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	48.33	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	48.32	48.32	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	49.10	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	46.04	46.04	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	48.32	8.13	HGL Too High!
P42	DI31	MH22	1.00	39.12	39.12	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	39.17	5.12	HGL Too High!
P43	MH22	DI32	1.00	39.09	39.09	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	39.12	5.45	HGL Too High!
P44	DI32	EX	1.00	38.45	38.45	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	39.09	5.23	HGL Too High!
P46	DI34	DI33	1.00	39.17	39.17	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	39.17	5.47	HGL Too High!
P45	DI33	DI32	1.00	39.09	39.09	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	39.17	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	23.59	23.59	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	23.59	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	46.33	46.33	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	46.45	3.63	HGL Too High!
P48	DI40	DI41	0.80	46.33	46.33	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	46.34	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	46.04	46.04	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	46.33	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	22.68	22.68	15	0.5	0.4	90	27.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.68	7.41	
P5	MH1	MH2	1.20	22.67	22.67	18	0.9	0.5	0	82.7	0.0001	0.01	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	90	0.00	0.00	1.3	0.5	0.00	0.01	22.68	7.93	HGL Too High!
P7	MH2	MH3	1.20	22.66	22.66	18	1.4	0.8	1	73.8	0.0002	0.01	0	0.00	0.00	0.5	0.2	0.0	0.5	0.0	0	0.00	0.00	1.0	0.5	0.00	0.01	22.67	7.65	HGL Too High!
P10	MH3	MH4	1.20	22.63	22.63	18	2.5	1.4	8	53.7	0.0005	0.03	0	0.00	0.01	1.1	0.3	0.3	0.8	0.0	1	0.00	0.01	1.0	0.5	0.01	0.03	22.66	7.28	HGL Too High!
P13	MH4	MH5	1.20	22.52	22.52	18	4.3	2.5	84	59.3	0.0015	0.09	0	0.00	0.02	3.6	1.0	0.8	1.4	0.0	8	0.00	0.04	1.0	0.5	0.02	0.11	22.63	7.09	HGL Too High!
P15	MH5	MH20	1.60	22.39	22.39	24	6.5	2.1	90	104	0.0007	0.07	0	0.00	0.02	10.7	1.5	0.4	2.5	0.0	84	0.06	0.11	1.0	0.5	0.06	0.13	22.52	7.40	HGL Too High!
P6	DI16	MH2	1.00	22.67	22.67	15	0.5	0.4	86	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.67	7.33	HGL Too High!
P9	DI3	MH3	1.00	22.66	22.66	15	0.6	0.5	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.66	6.62	HGL Too High!
P8	DI17	MH3	1.00	22.66	22.66	15	0.6	0.5	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.66	6.96	HGL Too High!
P12	DI4	MH4	1.00	22.63	22.63	15	1.1	0.9	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.63	6.48	HGL Too High!
P11	DI18	MH4	1.00	22.63	22.63	15	1.0	0.8	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.63	6.56	HGL Too High!
P14	DI5	MH5	1.00	22.52	22.52	15	0.7	0.6	21	22.6	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.52	6.61	HGL Too High!
P18	DI6	MH6	1.00	22.53	22.53	15	1.0	0.8	23	38	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.54	7.13	HGL Too High!
P16	MH6	MH5	1.20	22.52	22.52	18	1.6	0.9	86	40	0.0002	0.01	0	0.00	0.00	0.8	0.3	0.0	0.8	0.0	23	0.00	0.01	1.0	0.5	0.00	0.01	22.53	7.55	HGL Too High!
P17	DI19	MH6	1.00	22.53	22.53	15	0.7	0.5	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.54	7.08	HGL Too High!
P32	DI23	MH12	1.00	23.91	23.91	15	0.8	0.6	64	33.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.91	4.24	HGL Too High!
P31	DI9	MH12	1.00	23.91	23.91	15	0.6	0.5	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.91	7.13	HGL Too High!
P30	MH12	MH11	1.60	23.89	23.89	24	1.4	0.4	1	50.1	0.0001	0.01	0	0.00	0.00	0.3	0.5	0.0	0.6	0.0	64	0.00	0.01	1.0	0.5	0.00	0.01	23.91	7.48	HGL Too High!
P27	MH11	MH10	1.60	23.85	23.85	24	2.8	0.9	5	73.2	0.0006	0.05	0	0.00	0.00	0.6	0.5	0.4	0.4	0.0	1	0.00	0.00	1.0	0.5	0.00	0.05	23.89	7.21	HGL Too High!
P25	MH10	MH9	1.60	23.83	23.83	24	3.2	1.0	5	69.7	0.0002	0.01	0	0.00	0.00	2.6	0.1	0.0	0.9	0.0	5	0.00	0.01	1.0	0.5	0.00	0.02	23.85	7.54	HGL Too High!
P22	MH9	MH8	1.60	23.79	23.79	24	4.0	1.3	51	108	0.0003	0.03	0	0.00	0.01	3.2	0.2	0.2	1.0	0.0	5	0.00	0.01	1.0	0.5	0.01	0.04	23.83	7.85	HGL Too High!
P20	MH8	MH21	1.60	23.75	23.75	24	5.2	1.7	90	57.3	0.0005	0.03	0	0.00	0.01	5.1	1.5	0.0	1.3	0.0	51	0.01	0.03	1.0	0.5	0.02	0.04	23.79	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	23.72	23.72	24	5.2	1.7	21	11.3	0.0004	0.01	0	0.00	0.01	8.6	0.0	0.0	1.7	0.0	90	0.03	0.06	1.0	0.5	0.03	0.03	23.75	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	23.72	23.72	18	4.0	2.3	35	7.75	0.0013	0.01	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	26	0.00	0.02	1.0	1.0	0.02	0.03	23.75	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	23.79	23.79	15	1.3	1.1	35	49	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	26	0.00	0.00	1.0	1.0	0.00	0.02	23.82	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	23.93	23.93	8	1.2	3.4	45	17	0.0082	0.14	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.18	24.11	4.78	HGL Too High!
P51	STUB	DI22	1.00	23.93	23.93	15	2.9	2.3	0	10	0.0017	0.02	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	0.5	0.01	0.03	23.96	7.16	HGL Too High!
P28	DI22	MH11	1.00	23.89	23.89	15	0.8	0.6	90	30.3	0.0001	0.00	0	0.00	0.00	6.7	4.0	0.0	2.3	0.0	0	0.00	0.03	1.0	1.0	0.03	0.04	23.93	6.74	HGL Too High!
P29	DI8	MH11	1.00	23.89	23.89	15	0.7	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.90	6.92	HGL Too High!
P26	DI21	MH10	1.00	23.85	23.85	15	0.4	0.3	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.85	7.23	HGL Too High!
P23	DI20	MH9	1.00	23.83	23.83	15	0.5	0.4	85	29.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	23.83	7.38	HGL Too High!
P24	DI7	MH9	1.00	23.83	23.83	15	0.4	0.4	47	28	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.83	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	48.54	48.54	15	0.8	0.7	90	16	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	48.55	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	48.54	48.54	15	0.9	0.8	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	48.55	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	48.44	48.44	15	1.7	1.4	90	154	0.0006	0.10	0	0.00	0.01	0.5	0.7	0.0	0.8	0.0	90	0.01	0.02	1.0	0.5	0.01	0.11	48.54	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	48.31	48.31	15	4.2	3.4	90	23	0.0042	0.10	0	0.00	0.04	2.5	5.2	0.0	2.1	0.0	0	0.00	0.07	1.0	0.5	0.03	0.13	48.44	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	47.72	47.72	15	5.0	4.1	0	78	0.0059	0.46	0	0.00	0.06	14.2	0.6	0.0	3.4	0.1	90	0.13	0.25	1.0	0.5	0.13	0.59	48.31	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	47.34	47.34	15	4.9	4.0	0	54	0.0057	0.31	0	0.00	0.06	20.2	0.0	0.0	4.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.38	47.72	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	39.75	39.75	15	10.6	8.6	0	263	0.0269	7.09	0	0.00	0.29	19.3	24.2	8.9	6.7	0.2	90	0.48	1.01	1.0	0.5	0.51	7.59	47.34	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	34.26	34.26	15	14.7	12.0	0	96	0.0521	5.00	0	0.00	0.56	91.6	29.4	0.0	8.6	0.4	0	0.00	0.97	1.0	0.5	0.48	5.48	39.75	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	24.89	24.89	15	14.4	11.7	60	175	0.0498	8.72	0	0.00	0.54	177.1	0.0	0.0	12.0	0.8	0	0.00	1.32	1.0	0.5	0.66	9.38	34.26	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	23.72	23.72	24	13.8	4.4	84	41	0.0037	0.15	0	0.00	0.08	169.4	0.0	0.0	11.7	0.8	60	1.20	2.03	1.0	0.5	1.01	1.17	24.89	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	22.39	22.39	24	21.2	6.7	13	124	0.0088	1.09	0	0.00	0.18	60.8	8.6	9.2	4.4	0.1	84	0.20	0.49	1.0	0.5	0.24	1.33	23.72	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	21.86	21.86	24	26.3	8.4	78	8	0.0135	0.11	0	0.00	0.27	142.9	0.0	0.0	6.7	0.2	13	0.13	0.65	1.3	0.5	0.43	0.53	22.39	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	17.76	17.76	24	26.3	8.4	0	252	0.0135	3.41	0	0.00	0.27	220.6	0.0	0.0	8.4	0.4	78	0.72	1.37	1.0	0.5	0.69	4.10	21.86	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	14.83	14.83	24	24.6	7.8	25	221	0.0119	2.62	0	0.00	0.24	220.6	0.0	0.0	8.4	0.4	0	0.00	0.62	1.0	0.5	0.31	2.93	17.76	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**13.34**	**13.34**	**24**	**23.6**	**7.5**	**0**	**98**	**0.0109**	**1.07**	**0**	**0.00**	**0.22**	**193.1**	**0.0**	**0.0**	**7.8**	**0.3**	**25**	**0.29**	**0.84**	**1.0**	**0.5**	**0.42**	**1.49**	**14.83**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	49.80	49.80	4	1.2	13.7	0	16	0.3346	5.35	0	0.00	0.73	0.0	0.0	0.0	0.0	0.0	0	0.00	0.73	1.0	0.5	0.36	5.72	55.52	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	49.80	49.80	8	0.3	0.9	90	33	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	49.82	6.45	HGL Too High!
P3	DI14	DI13	1.00	49.80	49.80	15	0.5	0.4	90	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	49.81	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	48.44	48.44	15	2.5	2.1	0	15	0.0015	0.02	0	0.00	0.02	0.2	16.3	0.3	13.7	1.0	0	0.00	1.03	1.3	1.0	1.34	1.36	49.80	6.58	HGL Too High!
P2	DI2	DI1	1.00	48.32	48.32	15	0.5	0.4	70	69.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	48.32	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	10	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	48.31	48.31	15	0.9	0.7	111	3.34	0.0002	0.00	0	0.00	0.00	0.2	0.0	0.0	0.4	0.0	70	0.00	0.00	1.3	1.0	0.01	0.01	48.32	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	49.62	49.62	8	0.2	0.6	104	46	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	49.63	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	49.62	49.62	12	3.5	4.4	90	87	0.0081	0.71	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.78	50.40	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	47.34	47.34	10	3.6	6.7	90	87	0.0234	2.03	0	0.00	0.17	15.4	0.1	0.0	4.4	0.1	90	0.21	0.49	1.0	0.5	0.25	2.28	49.62	8.13	HGL Too High!
P42	DI31	MH22	1.00	40.42	40.42	15	1.7	1.4	7.5	55.8	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	40.47	5.12	HGL Too High!
P43	MH22	DI32	1.00	40.39	40.39	15	1.7	1.4	80	45.1	0.0006	0.03	0	0.00	0.01	2.4	0.0	0.0	1.4	0.0	7.5	0.00	0.02	1.0	0.5	0.01	0.04	40.42	5.45	HGL Too High!
P44	DI32	EX	1.00	39.75	39.75	15	6.0	4.9	90	59.3	0.0074	0.44	0	0.00	0.09	2.3	4.9	0.0	2.0	0.0	94	0.04	0.16	1.3	1.0	0.20	0.64	40.39	5.23	HGL Too High!
P46	DI34	DI33	1.00	40.47	40.47	15	0.3	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	40.47	5.47	HGL Too High!
P45	DI33	DI32	1.00	40.39	40.39	15	2.4	2.0	94	48.5	0.0012	0.06	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.02	0.08	40.47	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	24.89	24.89	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	24.89	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	47.63	47.63	12	1.8	2.3	0	47	0.0022	0.10	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.12	47.75	3.63	HGL Too High!
P48	DI40	DI41	0.80	47.63	47.63	12	0.5	0.6	90	82.1	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	47.64	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	47.34	47.34	12	2.6	3.4	95	41	0.0047	0.19	0	0.00	0.04	0.3	4.1	0.0	2.3	0.0	0	0.00	0.07	1.3	1.0	0.09	0.29	47.63	4.62	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 25 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
MARKET ST RIVER WEST OUTFALL																										
SOUTH SECTION TO 24"																										
P4	DI15	MH1	3244	1216	4460	0.10	0.81	0.08	0.08	6.0	0.00	6.84	0.6	15	27.3	0.012	0.000066	0.005	4.1	5.0	2.5	0.19	6.19	4.49	4.35	Q ok
P5	MH1	MH2	1	0	1	0.00	1.00	0.00	0.17	6.0	6.19	6.78	1.2	18	82.7	0.012	0.000104	0.005	4.5	8.0	3.2	0.43	6.62	4.25	3.84	Q ok
P7	MH2	MH3	1	0	1	0.00	1.00	0.00	0.26	6.0	6.62	6.67	1.7	18	73.8	0.012	0.000229	0.005	4.6	8.1	3.4	0.36	6.98	3.81	3.44	Q ok
P10	MH3	MH4	1	0	1	0.00	1.00	0.00	0.47	6.0	6.98	6.55	3.1	18	53.7	0.012	0.000745	0.005	4.6	8.1	4.2	0.21	7.19	3.34	3.07	Q ok
P13	MH4	MH5	1	0	1	0.00	1.00	0.00	0.82	6.0	7.19	6.49	5.3	18	59.3	0.012	0.002192	0.005	4.3	7.7	4.7	0.21	7.40	2.97	2.70	Q ok
P15	MH5	MH20	1	0	1	0.00	1.00	0.00	1.24	6.0	7.40	6.43	8.0	24	104.1	0.012	0.001065	0.020	11.1	34.8	9.1	0.19	7.59	2.60	0.50	Q ok
P6	DI16	MH2	3400	1275	4675	0.11	0.81	0.09	0.09	6.0	0.00	6.84	0.6	15	29.3	0.012	0.000073	0.005	4.1	5.0	2.4	0.20	6.20	4.06	3.91	Q ok
P9	DI3	MH3	4110	3259	7369	0.17	0.67	0.11	0.11	6.0	0.00	6.84	0.8	15	18.3	0.012	0.000123	0.005	4.0	4.9	2.8	0.11	6.11	3.68	3.59	Q ok
P8	DI17	MH3	3878	2100	5978	0.14	0.75	0.10	0.10	6.0	0.00	6.84	0.7	15	31.3	0.012	0.000101	0.005	4.2	5.2	2.9	0.18	6.18	3.71	3.54	Q ok
P12	DI4	MH4	7109	2561	9670	0.22	0.82	0.18	0.18	6.0	0.00	6.73	1.2	15	20.1	0.012	0.000307	0.005	4.0	4.9	3.3	0.10	6.10	3.48	3.38	Q ok
P11	DI18	MH4	6435	2210	8645	0.20	0.83	0.16	0.16	6.0	0.00	6.70	1.1	15	28.4	0.012	0.000248	0.005	4.1	5.1	3.1	0.15	6.15	3.48	3.33	Q ok
P14	DI5	MH5	4974	2549	7523	0.17	0.76	0.13	0.13	6.0	0.00	6.84	0.9	15	22.6	0.012	0.000164	0.005	4.0	4.9	3.0	0.12	6.12	3.68	3.57	Q ok
P18	DI6	MH6	6937	1863	8800	0.20	0.87	0.17	0.17	6.0	0.00	6.84	1.2	15	38.0	0.012	0.000292	0.005	4.0	4.9	3.3	0.19	6.19	4.57	4.38	Q ok
P16	MH6	MH5	1	0	1	0.00	1.00	0.00	0.29	6.0	6.19	6.78	2.0	18	40.0	0.012	0.000302	0.011	6.8	12.1	4.8	0.14	6.33	3.77	3.32	Q ok
P17	DI19	MH6	4542	1703	6245	0.14	0.81	0.12	0.12	6.0	0.00	6.84	0.8	15	33.0	0.012	0.000130	0.005	4.0	4.9	2.8	0.20	6.20	4.19	4.02	Q ok
NORTH SECTION TO 24"																										
P32	DI23	MH12	5495	1914	7409	0.17	0.83	0.14	0.14	6.0	0.00	6.84	1.0	15	33.31	0.012	0.0002	0.005	4.1	5.0	3.1	0.18	6.18	3.98	3.81	Q ok
P31	DI9	MH12	4483	551	5034	0.12	0.95	0.11	0.11	6.0	0.00	6.84	0.8	15	18.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.11	6.11	3.86	3.77	Q ok
P30	MH12	MH11	1	0	1	0.00	1.00	0.00	0.25	6.0	6.18	6.78	1.7	18	50.1	0.012	0.0002	0.005	4.5	8.0	3.4	0.24	6.43	3.67	3.42	Q ok
P27	MH11	MH10	1	0	1	0.00	1.00	0.00	0.52	6.0	6.43	6.72	3.5	18	73.2	0.012	0.0009	0.005	4.6	8.1	4.4	0.27	6.70	3.39	3.02	Q ok
P25	MH10	MH9	1	0	1	0.00	1.00	0.00	0.59	6.0	6.70	6.64	3.9	24	69.68	0.012	0.0003	0.006	6.3	19.7	4.7	0.25	6.95	2.92	2.47	Q ok
P22	MH9	MH8	1	0	1	0.00	1.00	0.00	0.75	6.0	6.95	6.58	4.9	24	108.3	0.012	0.0004	0.005	5.5	17.3	4.7	0.38	7.33	2.47	1.93	Q ok
P20	MH8	MH21	1	0	1	0.00	1.00	0.00	0.98	6.0	7.33	6.46	6.3	24	57.3	0.012	0.0007	0.021	11.4	35.8	8.5	0.11	7.44	1.65	0.43	Q ok
P21	MH21	EXMH1	1	0	1	0.00	1.00	0.00	0.98	6.0	7.44	6.43	6.3	24	11.3	0.012	0.0007	0.005	5.7	17.9	5.1	0.04	7.48	0.33	0.27	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 25 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P47	DI35	EXMH1	29988	0	29988	0.69	1.00	0.69	0.69	6.0	0.00	6.84	4.7	18	7.75	0.012	0.0017	0.008	5.8	10.3	5.6	0.02	6.02	-0.50	-0.56	Q ok
P-80	DI-80	MH-08	9967	0	9967	0.23	1.00	0.23	0.23	6.0	0.00	6.84	1.6	15	49	0.012	0.0005	0.009	5.5	6.8	4.5	0.18	6.18	4.53	4.07	Q ok
P52	TDI50	DI22	8815	0	8815	0.20	1.00	0.20	0.20	6.0	0.00	6.84	1.4	8	17	0.012	0.0112	0.010	3.8	1.3	3.1	0.09	6.09	3.92	3.75	Undersized!
P51	STUB	DI22	21322	0	21322	0.49	1.00	0.49	0.49	6.0	0.00	6.84	3.3	15	10.02	0.012	0.0023	0.005	4.0	4.9	4.4	0.04	6.04	3.79	3.74	Q ok
P28	DI22	MH11	5555	1955	7510	0.17	0.82	0.14	0.14	6.0	0.00	6.84	1.0	15	30.3	0.012	0.0002	0.005	4.0	4.9	3.0	0.17	6.17	3.64	3.49	Q ok
P29	DI8	MH11	5120	570	5690	0.13	0.96	0.13	0.13	6.0	0.00	6.84	0.9	15	18.3	0.012	0.0002	0.005	4.0	4.9	2.8	0.11	6.11	3.64	3.55	Q ok
P26	DI21	MH10	2755	930	3685	0.08	0.83	0.07	0.07	6.0	0.00	6.84	0.5	15	18.3	0.012	0.0000	0.005	4.0	4.9	2.4	0.13	6.13	4.02	3.93	Q ok
P23	DI20	MH9	3213	1102	4315	0.10	0.83	0.08	0.08	6.0	0.00	6.84	0.6	15	29.3	0.012	0.0001	0.005	4.0	4.9	2.4	0.20	6.20	4.53	4.38	Q ok
P24	DI7	MH9	3164	527	3691	0.08	0.92	0.08	0.08	6.0	0.00	6.84	0.5	15	28.02	0.012	0.0001	0.005	4.0	4.9	2.4	0.19	6.19	4.38	4.24	Q ok
SOUTH SECTION LOW TRUNK TO 24" OUTFALL																										
CRB-P72	CRB-DI72	CRB-MH-74	6086	0	6086	0.14	1.00	0.14	0.14	6.0	0.00	6.84	1.0	15	16	0.012	0.0002	0.019	7.8	9.6	4.7	0.06	6.06	2.60	2.30	Q ok
CRB-P73	CRB-DI73	CRB-MH-74	7042	0	7042	0.16	1.00	0.16	0.16	6.0	0.00	6.84	1.1	15	34	0.012	0.0002	0.005	4.0	4.9	3.0	0.19	6.19	1.92	1.75	Q ok
CRB-P74	CRB-MH-74	CRB-MH-67	1	0	1	0.00	1.00	0.00	0.30	6.0	6.19	6.78	2.0	15	154	0.012	0.0009	0.005	4.1	5.1	3.8	0.67	6.86	1.65	0.84	Q ok
EXP2	CRB-MH-67	EXMH3	1	0	1	0.00	1.00	0.00	0.75	6.0	6.86	6.58	4.9	15	23	0.013	0.0058	***0.003***	***2.7***	3.3	2.2	0.17	7.04	-1.14	-1.20	Undersized!
EXP3	EXMH3	EXMH4	1	0	1	0.00	1.00	0.00	0.91	6.0	7.04	6.55	5.9	15	78	0.013	0.0084	***0.003***	***2.7***	3.3	2.2	0.59	7.63	-1.20	-1.40	Undersized!
EXP4	EXMH4	EXMH5	1	0	1	0.00	1.00	0.00	0.91	6.0	7.63	6.38	5.8	15	54	0.013	0.0080	***0.003***	***2.7***	3.3	2.2	0.41	8.04	-1.40	-1.54	Undersized!
EXP5	EXMH5	EXMH6	1	0	1	0.00	1.00	0.00	2.03	6.0	8.04	6.26	12.7	15	263	0.013	0.0386	***0.003***	***2.7***	3.3	2.2	2.00	10.04	-1.54	-2.22	Undersized!
EXP6	EXMH6	EXMH7	1	0	1	0.00	1.00	0.00	3.08	6.0	10.04	5.68	17.5	15	96	0.013	0.0731	***0.003***	***2.7***	3.3	2.2	0.73	10.77	-2.22	-2.47	Undersized!
EXP7	EXMH7	EXMH8	1	0	1	0.00	1.00	0.00	3.08	6.0	10.77	5.54	17.0	15	175	0.013	0.0696	***0.003***	***2.7***	3.3	2.2	1.33	12.09	-2.47	-2.92	Undersized!
EXP8	EXMH8	EXMH9	1	0	1	0.00	1.00	0.00	3.08	6.0	12.09	5.31	16.3	24	41	0.013	0.0052	0.009	6.8	21.4	7.6	0.09	12.18	-2.92	-3.29	Q ok
EXP9	EXMH9	EXMH10	1	0	1	0.00	1.00	0.00	4.74	6.0	12.18	5.29	25.1	24	124	0.013	0.0123	0.009	6.8	21.4	5.6	0.37	12.55	-3.29	-4.40	Undersized!
EXP10	EXMH10	EXMH11	1	0	1	0.00	1.00	0.00	5.99	6.0	12.55	5.22	31.3	24	8	0.013	0.0191	***0.001***	***2.7***	8.5	2.2	0.06	12.61	-4.40	-4.41	Undersized!
EXP11	EXMH11	EXMH12	1	0	1	0.00	1.00	0.00	5.99	6.0	12.61	5.22	31.3	24	252	0.013	0.0191	***0.001***	***2.7***	8.5	2.2	1.90	14.52	-4.41	-4.76	Undersized!
EXP12	EXMH12	EXMH13	1	0	1	0.00	1.00	0.00	5.99	6.0	14.52	4.89	29.3	24	221	0.013	0.0167	***0.001***	***2.7***	8.5	2.2	1.67	16.18	-4.76	-5.07	Undersized!
EXP13	**EXMH13**	**OUTFALL**	**1**	**0**	**1**	**0.00**	1.00	**0.00**	**5.99**	**6.0**	**16.18**	4.70	28.1	**24**	**98**	**0.013**	**0.0155**	***0.001***	***2.7***	**8.5**	**2.2**	**0.74**	**16.92**	**-5.07**	**-5.21**	**Undersized!**
ROOF	COLLINS	MSS DI-13	8875	0	8875	0.20	1.00	0.20	0.20	6.0	0.00	6.84	1.4	4	16	0.012	0.4569	0.019	3.2	0.3	2.7	0.10	6.10	2.60	2.30	Undersized!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 25 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
CRB-P75	TD-03	MSS DI-13	2341	0	2341	0.05	1.00	0.05	0.05	6.0	0.00	6.84	**0.37**	8	33	0.011	0.000663	0.0348	7.6	**2.7**	5.3	0.10	6.10	4.57	3.42	Q ok
P3	DI14	DI13	3876	441	4317	0.10	0.96	0.09	0.09	6.0	0.00	6.84	0.6	15	69.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.41	6.41	4.03	3.68	Q ok
EXP1	DI13	MH67	3876	441	4317	0.10	0.96	0.09	0.45	6.0	6.41	6.72	3.0	15	15	0.013	0.0022	***0.003***	***2.7***	3.3	3.1	0.08	6.49	-1.10	-1.14	Q ok
P2	DI2	DI1	3846	1139	4985	0.11	0.85	0.10	0.10	6.0	0.00	6.84	0.7	15	69.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.41	6.41	4.03	3.68	Q ok
P1	DI1	EXMH	2301	1082	3383	0.08	0.77	0.06	0.16	6.0	6.41	6.72	1.1	15	3.34	0.012	0.0002	0.005	4.0	4.9	3.0	0.02	6.43	3.39	3.37	Q ok
CRB-P84	TD-04	EXMH	1667	0	1667	0.04	1.00	0.04	0.04	6.0	0.00	6.84	**0.26**	8	46	0.011	0.000336	0.0383	8.0	**2.8**	4.8	0.16	6.16	6.26	4.50	Q ok
EXP15	EXDI	EXMH	24757	6130	30887	0.71	0.88	0.62	0.62	6.0	0.00	6.84	**4.25**	12	87	0.012	0.012142	0.0049	3.5	**2.7**	2.8	0.51	6.51	2.00	1.57	Undersized!
EXP16	EXMH	EXMH5	1	0	1	0.00	1.00	0.00	0.66	6.0	6.51	6.70	**4.42**	10	87	0.012	0.034664	0.0049	3.1	**1.7**	2.5	0.58	7.09	2.00	1.57	Undersized!
P42	DI31	MH22	12796.5	0	12797	0.29	1.00	0.29	0.29	6.0	0.00	6.84	2.0	15	55.8	0.012	0.0008	0.005	4.0	5.0	3.7	0.25	6.25	2.00	1.72	Q ok
P43	MH22	DI32	1	0	1	0.00	1.00	0.00	0.29	6.0	6.25	6.75	2.0	15	45.1	0.012	0.0008	0.005	4.1	5.0	3.7	0.20	6.45	1.62	1.39	Q ok
P44	DI32	EX	14459.5	0	14460	0.33	1.00	0.33	1.05	6.0	6.45	6.70	7.0	15	59.3	0.012	0.0101	0.030	9.9	12.1	10.4	0.10	6.55	1.29	0.70	Q ok
P46	DI34	DI33	2420	0	2420	0.06	1.00	0.06	0.06	6.0	0.00	6.84	0.4	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.4	0.26	6.26	2.00	1.82	Q ok
P45	DI33	DI32	15975	0	15975	0.37	1.00	0.37	0.42	6.0	6.26	6.75	2.9	15	48.5	0.012	0.0017	0.007	4.7	5.8	4.7	0.17	6.43	1.72	1.39	Q ok
EXP17	EXMH	EXMH8	1	0	1	0.00	1.00	0.00	0.00	6.0	0.00	6.84	0.0	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.0	0.32	6.32	2.00	1.82	Q ok
EX-P LOT	EXDI LOT	DI-MSS-41	13430	0	13430	0.31	1.00	0.31	0.31	6.0	0.00	6.84	**2.11**	12	47	0.012	0.002985	0.0074	4.2	**3.3**	4.5	0.17	6.17	2.50	2.15	Q ok
P48	DI40	DI41	3590	0	3590	0.08	1.00	0.08	0.08	6.0	0.00	6.84	0.6	12	82.1	0.012	0.0002	0.005	3.5	2.7	2.6	0.53	6.53	2.56	2.15	Q ok
P-MSS-48A	DI-MSS-41	EX-MH LOW	3072	0	3072	0.07	1.00	0.07	0.46	6.0	6.53	6.70	**3.09**	12	41	0.012	0.006401	0.0051	3.5	**2.8**	2.9	0.24	6.76	2.05	1.84	Undersized!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	16.41	16.41	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.41	7.41	
P5	MH1	MH2	1.20	16.40	16.40	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	16.41	7.93	HGL Too High!
P7	MH2	MH3	1.20	16.38	16.38	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	16.40	7.65	HGL Too High!
P10	MH3	MH4	1.20	16.33	16.33	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	16.38	7.28	HGL Too High!
P13	MH4	MH5	1.20	16.17	16.17	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	16.33	7.09	HGL Too High!
P15	MH5	MH20	1.60	15.97	15.97	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	16.17	7.40	HGL Too High!
P6	DI16	MH2	1.00	16.40	16.40	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.40	7.33	HGL Too High!
P9	DI3	MH3	1.00	16.38	16.38	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.38	6.62	HGL Too High!
P8	DI17	MH3	1.00	16.38	16.38	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.38	6.96	HGL Too High!
P12	DI4	MH4	1.00	16.33	16.33	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.34	6.48	HGL Too High!
P11	DI18	MH4	1.00	16.33	16.33	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.34	6.56	HGL Too High!
P14	DI5	MH5	1.00	16.17	16.17	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.17	6.61	HGL Too High!
P18	DI6	MH6	1.00	16.19	16.19	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.20	7.13	HGL Too High!
P16	MH6	MH5	1.20	16.17	16.17	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	16.19	7.55	HGL Too High!
P17	DI19	MH6	1.00	16.19	16.19	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.19	7.08	HGL Too High!
P32	DI23	MH12	1.00	18.12	18.12	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.13	4.24	HGL Too High!
P31	DI9	MH12	1.00	18.12	18.12	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.12	7.13	HGL Too High!
P30	MH12	MH11	1.60	18.10	18.10	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	18.12	7.48	HGL Too High!
P27	MH11	MH10	1.60	18.03	18.03	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	18.10	7.21	HGL Too High!
P25	MH10	MH9	1.60	18.00	18.00	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	18.03	7.54	HGL Too High!
P22	MH9	MH8	1.60	17.95	17.95	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	18.00	7.85	HGL Too High!
P20	MH8	MH21	1.60	17.89	17.89	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	17.95	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	17.84	17.84	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	17.89	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	17.84	17.84	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	17.88	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	17.95	17.95	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	17.98	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	18.15	18.15	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	18.40	4.78	HGL Too High!
P51	STUB	DI22	1.00	18.15	18.15	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	18.19	7.16	HGL Too High!
P28	DI22	MH11	1.00	18.10	18.10	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	18.15	6.74	HGL Too High!
P29	DI8	MH11	1.00	18.10	18.10	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.10	6.92	HGL Too High!
P26	DI21	MH10	1.00	18.03	18.03	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.03	7.23	HGL Too High!
P23	DI20	MH9	1.00	18.00	18.00	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	18.01	7.38	HGL Too High!
P24	DI7	MH9	1.00	18.00	18.00	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.01	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	52.87	52.87	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	52.88	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	52.87	52.87	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	52.88	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	52.73	52.73	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	52.87	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	52.55	52.55	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	52.73	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	51.71	51.71	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	52.55	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	51.17	51.17	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	51.71	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	40.27	40.27	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	51.17	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	32.57	32.57	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	40.27	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	19.47	19.47	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	32.57	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	17.84	17.84	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	19.47	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	15.97	15.97	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	17.84	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	15.22	15.22	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	15.97	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	9.44	9.44	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	15.22	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	5.31	5.31	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	9.44	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.20**	**3.20**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	0.5	**0.59**	**2.11**	**5.31**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	54.59	54.59	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	62.40	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	54.59	54.59	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	54.62	6.45	HGL Too High!
P3	DI14	DI13	1.00	54.59	54.59	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	54.60	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	52.73	52.73	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	54.59	6.58	HGL Too High!
P2	DI2	DI1	1.00	52.56	52.56	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	52.56	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	52.55	52.55	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	52.56	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	54.55	54.55	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	54.57	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	54.55	54.55	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	55.72	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	51.17	51.17	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	54.55	8.13	HGL Too High!
P42	DI31	MH22	1.00	41.20	41.20	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	41.26	5.12	HGL Too High!
P43	MH22	DI32	1.00	41.15	41.15	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	41.20	5.45	HGL Too High!
P44	DI32	EX	1.00	40.27	40.27	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	41.15	5.23	HGL Too High!
P46	DI34	DI33	1.00	41.26	41.26	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	41.26	5.47	HGL Too High!
P45	DI33	DI32	1.00	41.15	41.15	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	41.26	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	19.47	19.47	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	19.47	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	51.56	51.56	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	51.73	3.63	HGL Too High!
P48	DI40	DI41	0.80	51.56	51.56	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	51.58	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	51.17	51.17	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	51.56	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	16.61	16.61	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.61	7.41	
P5	MH1	MH2	1.20	16.60	16.60	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	16.61	7.93	HGL Too High!
P7	MH2	MH3	1.20	16.58	16.58	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	16.60	7.65	HGL Too High!
P10	MH3	MH4	1.20	16.53	16.53	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	16.58	7.28	HGL Too High!
P13	MH4	MH5	1.20	16.37	16.37	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	16.53	7.09	HGL Too High!
P15	MH5	MH20	1.60	16.17	16.17	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	16.37	7.40	HGL Too High!
P6	DI16	MH2	1.00	16.60	16.60	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.60	7.33	HGL Too High!
P9	DI3	MH3	1.00	16.58	16.58	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.58	6.62	HGL Too High!
P8	DI17	MH3	1.00	16.58	16.58	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	16.58	6.96	HGL Too High!
P12	DI4	MH4	1.00	16.53	16.53	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.54	6.48	HGL Too High!
P11	DI18	MH4	1.00	16.53	16.53	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.54	6.56	HGL Too High!
P14	DI5	MH5	1.00	16.37	16.37	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.37	6.61	HGL Too High!
P18	DI6	MH6	1.00	16.39	16.39	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.40	7.13	HGL Too High!
P16	MH6	MH5	1.20	16.37	16.37	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	16.39	7.55	HGL Too High!
P17	DI19	MH6	1.00	16.39	16.39	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	16.39	7.08	HGL Too High!
P32	DI23	MH12	1.00	18.32	18.32	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.33	4.24	HGL Too High!
P31	DI9	MH12	1.00	18.32	18.32	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.32	7.13	HGL Too High!
P30	MH12	MH11	1.60	18.30	18.30	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	18.32	7.48	HGL Too High!
P27	MH11	MH10	1.60	18.23	18.23	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	18.30	7.21	HGL Too High!
P25	MH10	MH9	1.60	18.20	18.20	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	18.23	7.54	HGL Too High!
P22	MH9	MH8	1.60	18.15	18.15	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	18.20	7.85	HGL Too High!
P20	MH8	MH21	1.60	18.09	18.09	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	18.15	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	18.04	18.04	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	18.09	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	18.04	18.04	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	18.08	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	18.15	18.15	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	18.18	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	18.35	18.35	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	18.60	4.78	HGL Too High!
P51	STUB	DI22	1.00	18.35	18.35	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	18.39	7.16	HGL Too High!
P28	DI22	MH11	1.00	18.30	18.30	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	18.35	6.74	HGL Too High!
P29	DI8	MH11	1.00	18.30	18.30	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.30	6.92	HGL Too High!
P26	DI21	MH10	1.00	18.23	18.23	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.23	7.23	HGL Too High!
P23	DI20	MH9	1.00	18.20	18.20	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	18.21	7.38	HGL Too High!
P24	DI7	MH9	1.00	18.20	18.20	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.21	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	53.07	53.07	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	53.08	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	53.07	53.07	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	53.08	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	52.93	52.93	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	53.07	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	52.75	52.75	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	52.93	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	51.91	51.91	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	52.75	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	51.37	51.37	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	51.91	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	40.47	40.47	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	51.37	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	32.77	32.77	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	40.47	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	19.67	19.67	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	32.77	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	18.04	18.04	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	19.67	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	16.17	16.17	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	18.04	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	15.42	15.42	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	16.17	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	9.64	9.64	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	15.42	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	5.51	5.51	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	9.64	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.40**	**3.40**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	0.5	**0.59**	**2.11**	**5.51**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	54.79	54.79	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	62.60	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	54.79	54.79	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	54.82	6.45	HGL Too High!
P3	DI14	DI13	1.00	54.79	54.79	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	54.80	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	52.93	52.93	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	54.79	6.58	HGL Too High!
P2	DI2	DI1	1.00	52.76	52.76	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	52.76	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	52.75	52.75	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	52.76	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	54.75	54.75	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	54.77	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	54.75	54.75	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	55.92	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	51.37	51.37	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	54.75	8.13	HGL Too High!
P42	DI31	MH22	1.00	41.40	41.40	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	41.46	5.12	HGL Too High!
P43	MH22	DI32	1.00	41.35	41.35	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	41.40	5.45	HGL Too High!
P44	DI32	EX	1.00	40.47	40.47	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	41.35	5.23	HGL Too High!
P46	DI34	DI33	1.00	41.46	41.46	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	41.46	5.47	HGL Too High!
P45	DI33	DI32	1.00	41.35	41.35	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	41.46	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	19.67	19.67	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	19.67	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	51.76	51.76	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	51.93	3.63	HGL Too High!
P48	DI40	DI41	0.80	51.76	51.76	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	51.78	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	51.37	51.37	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	51.76	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	20.11	20.11	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.11	7.41	
P5	MH1	MH2	1.20	20.10	20.10	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	20.11	7.93	HGL Too High!
P7	MH2	MH3	1.20	20.08	20.08	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	20.10	7.65	HGL Too High!
P10	MH3	MH4	1.20	20.03	20.03	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	20.08	7.28	HGL Too High!
P13	MH4	MH5	1.20	19.87	19.87	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	20.03	7.09	HGL Too High!
P15	MH5	MH20	1.60	19.67	19.67	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	19.87	7.40	HGL Too High!
P6	DI16	MH2	1.00	20.10	20.10	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.10	7.33	HGL Too High!
P9	DI3	MH3	1.00	20.08	20.08	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.08	6.62	HGL Too High!
P8	DI17	MH3	1.00	20.08	20.08	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.08	6.96	HGL Too High!
P12	DI4	MH4	1.00	20.03	20.03	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.04	6.48	HGL Too High!
P11	DI18	MH4	1.00	20.03	20.03	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.04	6.56	HGL Too High!
P14	DI5	MH5	1.00	19.87	19.87	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.87	6.61	HGL Too High!
P18	DI6	MH6	1.00	19.89	19.89	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.90	7.13	HGL Too High!
P16	MH6	MH5	1.20	19.87	19.87	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	19.89	7.55	HGL Too High!
P17	DI19	MH6	1.00	19.89	19.89	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.89	7.08	HGL Too High!
P32	DI23	MH12	1.00	21.82	21.82	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.83	4.24	HGL Too High!
P31	DI9	MH12	1.00	21.82	21.82	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.82	7.13	HGL Too High!
P30	MH12	MH11	1.60	21.80	21.80	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	21.82	7.48	HGL Too High!
P27	MH11	MH10	1.60	21.73	21.73	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	21.80	7.21	HGL Too High!
P25	MH10	MH9	1.60	21.70	21.70	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	21.73	7.54	HGL Too High!
P22	MH9	MH8	1.60	21.65	21.65	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	21.70	7.85	HGL Too High!
P20	MH8	MH21	1.60	21.59	21.59	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	21.65	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	21.54	21.54	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	21.59	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	21.54	21.54	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	21.58	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	21.65	21.65	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	21.68	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	21.85	21.85	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	22.10	4.78	HGL Too High!
P51	STUB	DI22	1.00	21.85	21.85	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	21.89	7.16	HGL Too High!
P28	DI22	MH11	1.00	21.80	21.80	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	21.85	6.74	HGL Too High!
P29	DI8	MH11	1.00	21.80	21.80	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.80	6.92	HGL Too High!
P26	DI21	MH10	1.00	21.73	21.73	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.73	7.23	HGL Too High!
P23	DI20	MH9	1.00	21.70	21.70	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	21.71	7.38	HGL Too High!
P24	DI7	MH9	1.00	21.70	21.70	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.71	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	56.57	56.57	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	56.58	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	56.57	56.57	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	56.58	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	56.43	56.43	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	56.57	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	56.25	56.25	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	56.43	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	55.41	55.41	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	56.25	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	54.87	54.87	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	55.41	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	43.97	43.97	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	54.87	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	36.27	36.27	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	43.97	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	23.17	23.17	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	36.27	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	21.54	21.54	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	23.17	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	19.67	19.67	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	21.54	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	18.92	18.92	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	19.67	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.14	13.14	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	18.92	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.01	9.01	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	13.14	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**6.90**	**6.90**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	0.5	**0.59**	**2.11**	**9.01**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	58.29	58.29	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	66.10	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	58.29	58.29	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	58.32	6.45	HGL Too High!
P3	DI14	DI13	1.00	58.29	58.29	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	58.30	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	56.43	56.43	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	58.29	6.58	HGL Too High!
P2	DI2	DI1	1.00	56.26	56.26	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	56.26	6.84	HGL Too High!

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Hydraulic Grade Line Computations

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County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	56.25	56.25	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	56.26	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	58.25	58.25	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	58.27	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	58.25	58.25	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	59.42	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	54.87	54.87	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	58.25	8.13	HGL Too High!
P42	DI31	MH22	1.00	44.90	44.90	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	44.96	5.12	HGL Too High!
P43	MH22	DI32	1.00	44.85	44.85	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	44.90	5.45	HGL Too High!
P44	DI32	EX	1.00	43.97	43.97	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	44.85	5.23	HGL Too High!
P46	DI34	DI33	1.00	44.96	44.96	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	44.96	5.47	HGL Too High!
P45	DI33	DI32	1.00	44.85	44.85	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	44.96	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	23.17	23.17	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	23.17	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	55.26	55.26	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	55.43	3.63	HGL Too High!
P48	DI40	DI41	0.80	55.26	55.26	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	55.28	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	54.87	54.87	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	55.26	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	20.61	20.61	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.61	7.41	
P5	MH1	MH2	1.20	20.60	20.60	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	20.61	7.93	HGL Too High!
P7	MH2	MH3	1.20	20.58	20.58	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	20.60	7.65	HGL Too High!
P10	MH3	MH4	1.20	20.53	20.53	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	20.58	7.28	HGL Too High!
P13	MH4	MH5	1.20	20.37	20.37	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	20.53	7.09	HGL Too High!
P15	MH5	MH20	1.60	20.17	20.17	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	20.37	7.40	HGL Too High!
P6	DI16	MH2	1.00	20.60	20.60	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.60	7.33	HGL Too High!
P9	DI3	MH3	1.00	20.58	20.58	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.58	6.62	HGL Too High!
P8	DI17	MH3	1.00	20.58	20.58	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.58	6.96	HGL Too High!
P12	DI4	MH4	1.00	20.53	20.53	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.54	6.48	HGL Too High!
P11	DI18	MH4	1.00	20.53	20.53	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.54	6.56	HGL Too High!
P14	DI5	MH5	1.00	20.37	20.37	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.37	6.61	HGL Too High!
P18	DI6	MH6	1.00	20.39	20.39	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.40	7.13	HGL Too High!
P16	MH6	MH5	1.20	20.37	20.37	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	20.39	7.55	HGL Too High!
P17	DI19	MH6	1.00	20.39	20.39	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.39	7.08	HGL Too High!
P32	DI23	MH12	1.00	22.32	22.32	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.33	4.24	HGL Too High!
P31	DI9	MH12	1.00	22.32	22.32	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.32	7.13	HGL Too High!
P30	MH12	MH11	1.60	22.30	22.30	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	22.32	7.48	HGL Too High!
P27	MH11	MH10	1.60	22.23	22.23	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	22.30	7.21	HGL Too High!
P25	MH10	MH9	1.60	22.20	22.20	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	22.23	7.54	HGL Too High!
P22	MH9	MH8	1.60	22.15	22.15	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	22.20	7.85	HGL Too High!
P20	MH8	MH21	1.60	22.09	22.09	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	22.15	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	22.04	22.04	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	22.09	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	22.04	22.04	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	22.08	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	22.15	22.15	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	22.18	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	22.35	22.35	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	22.60	4.78	HGL Too High!
P51	STUB	DI22	1.00	22.35	22.35	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	22.39	7.16	HGL Too High!
P28	DI22	MH11	1.00	22.30	22.30	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	22.35	6.74	HGL Too High!
P29	DI8	MH11	1.00	22.30	22.30	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.30	6.92	HGL Too High!
P26	DI21	MH10	1.00	22.23	22.23	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.23	7.23	HGL Too High!
P23	DI20	MH9	1.00	22.20	22.20	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	22.21	7.38	HGL Too High!
P24	DI7	MH9	1.00	22.20	22.20	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.21	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	57.07	57.07	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	57.08	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	57.07	57.07	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	57.08	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	56.93	56.93	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	57.07	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	56.75	56.75	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	56.93	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	55.91	55.91	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	56.75	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	55.37	55.37	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	55.91	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	44.47	44.47	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	55.37	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	36.77	36.77	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	44.47	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	23.67	23.67	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	36.77	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	22.04	22.04	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	23.67	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	20.17	20.17	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	22.04	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	19.42	19.42	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	20.17	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.64	13.64	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	19.42	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.51	9.51	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	13.64	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.40**	**7.40**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	0.5	**0.59**	**2.11**	**9.51**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	58.79	58.79	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	66.60	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	58.79	58.79	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	58.82	6.45	HGL Too High!
P3	DI14	DI13	1.00	58.79	58.79	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	58.80	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	56.93	56.93	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	58.79	6.58	HGL Too High!
P2	DI2	DI1	1.00	56.76	56.76	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	56.76	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	56.75	56.75	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	56.76	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	58.75	58.75	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	58.77	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	58.75	58.75	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	59.92	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	55.37	55.37	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	58.75	8.13	HGL Too High!
P42	DI31	MH22	1.00	45.40	45.40	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	45.46	5.12	HGL Too High!
P43	MH22	DI32	1.00	45.35	45.35	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	45.40	5.45	HGL Too High!
P44	DI32	EX	1.00	44.47	44.47	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	45.35	5.23	HGL Too High!
P46	DI34	DI33	1.00	45.46	45.46	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	45.46	5.47	HGL Too High!
P45	DI33	DI32	1.00	45.35	45.35	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	45.46	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	23.67	23.67	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	23.67	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	55.76	55.76	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	55.93	3.63	HGL Too High!
P48	DI40	DI41	0.80	55.76	55.76	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	55.78	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	55.37	55.37	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	55.76	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	21.01	21.01	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.01	7.41	
P5	MH1	MH2	1.20	21.00	21.00	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	21.01	7.93	HGL Too High!
P7	MH2	MH3	1.20	20.98	20.98	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	21.00	7.65	HGL Too High!
P10	MH3	MH4	1.20	20.93	20.93	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	20.98	7.28	HGL Too High!
P13	MH4	MH5	1.20	20.77	20.77	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	20.93	7.09	HGL Too High!
P15	MH5	MH20	1.60	20.57	20.57	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	20.77	7.40	HGL Too High!
P6	DI16	MH2	1.00	21.00	21.00	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.00	7.33	HGL Too High!
P9	DI3	MH3	1.00	20.98	20.98	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.98	6.62	HGL Too High!
P8	DI17	MH3	1.00	20.98	20.98	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.98	6.96	HGL Too High!
P12	DI4	MH4	1.00	20.93	20.93	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.94	6.48	HGL Too High!
P11	DI18	MH4	1.00	20.93	20.93	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.94	6.56	HGL Too High!
P14	DI5	MH5	1.00	20.77	20.77	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.77	6.61	HGL Too High!
P18	DI6	MH6	1.00	20.79	20.79	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.80	7.13	HGL Too High!
P16	MH6	MH5	1.20	20.77	20.77	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	20.79	7.55	HGL Too High!
P17	DI19	MH6	1.00	20.79	20.79	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.79	7.08	HGL Too High!
P32	DI23	MH12	1.00	22.72	22.72	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.73	4.24	HGL Too High!
P31	DI9	MH12	1.00	22.72	22.72	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.72	7.13	HGL Too High!
P30	MH12	MH11	1.60	22.70	22.70	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	22.72	7.48	HGL Too High!
P27	MH11	MH10	1.60	22.63	22.63	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	22.70	7.21	HGL Too High!
P25	MH10	MH9	1.60	22.60	22.60	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	22.63	7.54	HGL Too High!
P22	MH9	MH8	1.60	22.55	22.55	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	22.60	7.85	HGL Too High!
P20	MH8	MH21	1.60	22.49	22.49	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	22.55	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	22.44	22.44	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	22.49	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	22.44	22.44	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	22.48	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	22.55	22.55	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	22.58	7.34	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	22.75	22.75	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	23.00	4.78	HGL Too High!
P51	STUB	DI22	1.00	22.75	22.75	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	22.79	7.16	HGL Too High!
P28	DI22	MH11	1.00	22.70	22.70	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	22.75	6.74	HGL Too High!
P29	DI8	MH11	1.00	22.70	22.70	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.70	6.92	HGL Too High!
P26	DI21	MH10	1.00	22.63	22.63	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.63	7.23	HGL Too High!
P23	DI20	MH9	1.00	22.60	22.60	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	22.61	7.38	HGL Too High!
P24	DI7	MH9	1.00	22.60	22.60	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.61	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	57.47	57.47	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	57.48	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	57.47	57.47	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	57.48	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	57.33	57.33	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	57.47	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	57.15	57.15	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	57.33	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	56.31	56.31	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	57.15	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	55.77	55.77	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	56.31	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	44.87	44.87	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	55.77	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	37.17	37.17	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	44.87	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	24.07	24.07	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	37.17	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	22.44	22.44	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	24.07	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	20.57	20.57	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	22.44	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	19.82	19.82	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	20.57	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	14.04	14.04	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	19.82	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.91	9.91	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	14.04	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.80**	**7.80**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	0.5	**0.59**	**2.11**	**9.91**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	59.19	59.19	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	67.00	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	59.19	59.19	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	59.22	6.45	HGL Too High!
P3	DI14	DI13	1.00	59.19	59.19	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	59.20	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	57.33	57.33	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	59.19	6.58	HGL Too High!
P2	DI2	DI1	1.00	57.16	57.16	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	57.16	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	57.15	57.15	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	57.16	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	59.15	59.15	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	59.17	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	59.15	59.15	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	60.32	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	55.77	55.77	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	59.15	8.13	HGL Too High!
P42	DI31	MH22	1.00	45.80	45.80	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	45.86	5.12	HGL Too High!
P43	MH22	DI32	1.00	45.75	45.75	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	45.80	5.45	HGL Too High!
P44	DI32	EX	1.00	44.87	44.87	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	45.75	5.23	HGL Too High!
P46	DI34	DI33	1.00	45.86	45.86	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	45.86	5.47	HGL Too High!
P45	DI33	DI32	1.00	45.75	45.75	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	45.86	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	24.07	24.07	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	24.07	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	56.16	56.16	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	56.33	3.63	HGL Too High!
P48	DI40	DI41	0.80	56.16	56.16	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	56.18	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	55.77	55.77	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	56.16	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	21.51	21.51	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.51	7.41	
P5	MH1	MH2	1.20	21.50	21.50	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	21.51	7.93	HGL Too High!
P7	MH2	MH3	1.20	21.48	21.48	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	21.50	7.65	HGL Too High!
P10	MH3	MH4	1.20	21.43	21.43	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	21.48	7.28	HGL Too High!
P13	MH4	MH5	1.20	21.27	21.27	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	21.43	7.09	HGL Too High!
P15	MH5	MH20	1.60	21.07	21.07	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	21.27	7.40	HGL Too High!
P6	DI16	MH2	1.00	21.50	21.50	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.50	7.33	HGL Too High!
P9	DI3	MH3	1.00	21.48	21.48	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.48	6.62	HGL Too High!
P8	DI17	MH3	1.00	21.48	21.48	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.48	6.96	HGL Too High!
P12	DI4	MH4	1.00	21.43	21.43	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.44	6.48	HGL Too High!
P11	DI18	MH4	1.00	21.43	21.43	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.44	6.56	HGL Too High!
P14	DI5	MH5	1.00	21.27	21.27	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.27	6.61	HGL Too High!
P18	DI6	MH6	1.00	21.29	21.29	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.30	7.13	HGL Too High!
P16	MH6	MH5	1.20	21.27	21.27	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	21.29	7.55	HGL Too High!
P17	DI19	MH6	1.00	21.29	21.29	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.29	7.08	HGL Too High!
P32	DI23	MH12	1.00	23.22	23.22	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.23	4.24	HGL Too High!
P31	DI9	MH12	1.00	23.22	23.22	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.22	7.13	HGL Too High!
P30	MH12	MH11	1.60	23.20	23.20	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	23.22	7.48	HGL Too High!
P27	MH11	MH10	1.60	23.13	23.13	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	23.20	7.21	HGL Too High!
P25	MH10	MH9	1.60	23.10	23.10	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	23.13	7.54	HGL Too High!
P22	MH9	MH8	1.60	23.05	23.05	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	23.10	7.85	HGL Too High!
P20	MH8	MH21	1.60	22.99	22.99	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	23.05	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	22.94	22.94	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	22.99	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	22.94	22.94	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	22.98	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	23.05	23.05	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	23.08	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	23.25	23.25	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	23.50	4.78	HGL Too High!
P51	STUB	DI22	1.00	23.25	23.25	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	23.29	7.16	HGL Too High!
P28	DI22	MH11	1.00	23.20	23.20	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	23.25	6.74	HGL Too High!
P29	DI8	MH11	1.00	23.20	23.20	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.20	6.92	HGL Too High!
P26	DI21	MH10	1.00	23.13	23.13	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.13	7.23	HGL Too High!
P23	DI20	MH9	1.00	23.10	23.10	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	23.11	7.38	HGL Too High!
P24	DI7	MH9	1.00	23.10	23.10	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.11	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	57.97	57.97	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	57.98	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	57.97	57.97	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	57.98	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	57.83	57.83	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	57.97	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	57.65	57.65	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	57.83	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	56.81	56.81	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	57.65	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	56.27	56.27	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	56.81	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	45.37	45.37	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	56.27	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	37.67	37.67	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	45.37	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	24.57	24.57	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	37.67	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	22.94	22.94	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	24.57	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	21.07	21.07	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	22.94	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	20.32	20.32	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	21.07	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	14.54	14.54	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	20.32	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.41	10.41	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	14.54	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**8.30**	**8.30**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	0.5	**0.59**	**2.11**	**10.41**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	59.69	59.69	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	67.50	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	59.69	59.69	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	59.72	6.45	HGL Too High!
P3	DI14	DI13	1.00	59.69	59.69	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	59.70	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	57.83	57.83	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	59.69	6.58	HGL Too High!
P2	DI2	DI1	1.00	57.66	57.66	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	57.66	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	57.65	57.65	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	57.66	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	59.65	59.65	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	59.67	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	59.65	59.65	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	60.82	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	56.27	56.27	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	59.65	8.13	HGL Too High!
P42	DI31	MH22	1.00	46.30	46.30	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	46.36	5.12	HGL Too High!
P43	MH22	DI32	1.00	46.25	46.25	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	46.30	5.45	HGL Too High!
P44	DI32	EX	1.00	45.37	45.37	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	46.25	5.23	HGL Too High!
P46	DI34	DI33	1.00	46.36	46.36	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	46.36	5.47	HGL Too High!
P45	DI33	DI32	1.00	46.25	46.25	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	46.36	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	24.57	24.57	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	24.57	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	56.66	56.66	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	56.83	3.63	HGL Too High!
P48	DI40	DI41	0.80	56.66	56.66	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	56.68	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	56.27	56.27	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	56.66	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	22.21	22.21	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.21	7.41	
P5	MH1	MH2	1.20	22.20	22.20	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	22.21	7.93	HGL Too High!
P7	MH2	MH3	1.20	22.18	22.18	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	22.20	7.65	HGL Too High!
P10	MH3	MH4	1.20	22.13	22.13	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	22.18	7.28	HGL Too High!
P13	MH4	MH5	1.20	21.97	21.97	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	22.13	7.09	HGL Too High!
P15	MH5	MH20	1.60	21.77	21.77	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	21.97	7.40	HGL Too High!
P6	DI16	MH2	1.00	22.20	22.20	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.20	7.33	HGL Too High!
P9	DI3	MH3	1.00	22.18	22.18	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.18	6.62	HGL Too High!
P8	DI17	MH3	1.00	22.18	22.18	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.18	6.96	HGL Too High!
P12	DI4	MH4	1.00	22.13	22.13	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.14	6.48	HGL Too High!
P11	DI18	MH4	1.00	22.13	22.13	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.14	6.56	HGL Too High!
P14	DI5	MH5	1.00	21.97	21.97	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.97	6.61	HGL Too High!
P18	DI6	MH6	1.00	21.99	21.99	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.00	7.13	HGL Too High!
P16	MH6	MH5	1.20	21.97	21.97	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	21.99	7.55	HGL Too High!
P17	DI19	MH6	1.00	21.99	21.99	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.99	7.08	HGL Too High!
P32	DI23	MH12	1.00	23.92	23.92	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.93	4.24	HGL Too High!
P31	DI9	MH12	1.00	23.92	23.92	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.92	7.13	HGL Too High!
P30	MH12	MH11	1.60	23.90	23.90	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	23.92	7.48	HGL Too High!
P27	MH11	MH10	1.60	23.83	23.83	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	23.90	7.21	HGL Too High!
P25	MH10	MH9	1.60	23.80	23.80	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	23.83	7.54	HGL Too High!
P22	MH9	MH8	1.60	23.75	23.75	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	23.80	7.85	HGL Too High!
P20	MH8	MH21	1.60	23.69	23.69	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	23.75	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	23.64	23.64	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	23.69	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	23.64	23.64	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	23.68	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	23.75	23.75	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	23.78	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	23.95	23.95	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	24.20	4.78	HGL Too High!
P51	STUB	DI22	1.00	23.95	23.95	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	23.99	7.16	HGL Too High!
P28	DI22	MH11	1.00	23.90	23.90	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	23.95	6.74	HGL Too High!
P29	DI8	MH11	1.00	23.90	23.90	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.90	6.92	HGL Too High!
P26	DI21	MH10	1.00	23.83	23.83	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.83	7.23	HGL Too High!
P23	DI20	MH9	1.00	23.80	23.80	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	23.81	7.38	HGL Too High!
P24	DI7	MH9	1.00	23.80	23.80	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.81	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	58.67	58.67	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	58.68	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	58.67	58.67	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	58.68	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	58.53	58.53	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	58.67	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	58.35	58.35	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	58.53	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	57.51	57.51	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	58.35	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	56.97	56.97	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	57.51	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	46.07	46.07	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	56.97	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	38.37	38.37	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	46.07	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	25.27	25.27	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	38.37	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	23.64	23.64	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	25.27	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	21.77	21.77	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	23.64	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	21.02	21.02	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	21.77	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.24	15.24	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	21.02	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.11	11.11	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	15.24	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.00**	**9.00**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	**0.5**	**0.59**	**2.11**	**11.11**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	60.39	60.39	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	68.20	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	60.39	60.39	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	60.42	6.45	HGL Too High!
P3	DI14	DI13	1.00	60.39	60.39	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	60.40	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	58.53	58.53	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	60.39	6.58	HGL Too High!
P2	DI2	DI1	1.00	58.36	58.36	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	58.36	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	58.35	58.35	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	58.36	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	60.35	60.35	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	60.37	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	60.35	60.35	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	61.52	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	56.97	56.97	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	60.35	8.13	HGL Too High!
P42	DI31	MH22	1.00	47.00	47.00	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	47.06	5.12	HGL Too High!
P43	MH22	DI32	1.00	46.95	46.95	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	47.00	5.45	HGL Too High!
P44	DI32	EX	1.00	46.07	46.07	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	46.95	5.23	HGL Too High!
P46	DI34	DI33	1.00	47.06	47.06	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	47.06	5.47	HGL Too High!
P45	DI33	DI32	1.00	46.95	46.95	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	47.06	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	25.27	25.27	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	25.27	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	57.36	57.36	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	57.53	3.63	HGL Too High!
P48	DI40	DI41	0.80	57.36	57.36	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	57.38	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	56.97	56.97	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	57.36	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	22.71	22.71	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.71	7.41	
P5	MH1	MH2	1.20	22.70	22.70	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	22.71	7.93	HGL Too High!
P7	MH2	MH3	1.20	22.68	22.68	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	22.70	7.65	HGL Too High!
P10	MH3	MH4	1.20	22.63	22.63	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	22.68	7.28	HGL Too High!
P13	MH4	MH5	1.20	22.47	22.47	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	22.63	7.09	HGL Too High!
P15	MH5	MH20	1.60	22.27	22.27	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	22.47	7.40	HGL Too High!
P6	DI16	MH2	1.00	22.70	22.70	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.70	7.33	HGL Too High!
P9	DI3	MH3	1.00	22.68	22.68	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.68	6.62	HGL Too High!
P8	DI17	MH3	1.00	22.68	22.68	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.68	6.96	HGL Too High!
P12	DI4	MH4	1.00	22.63	22.63	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.64	6.48	HGL Too High!
P11	DI18	MH4	1.00	22.63	22.63	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.64	6.56	HGL Too High!
P14	DI5	MH5	1.00	22.47	22.47	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.47	6.61	HGL Too High!
P18	DI6	MH6	1.00	22.49	22.49	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.50	7.13	HGL Too High!
P16	MH6	MH5	1.20	22.47	22.47	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	22.49	7.55	HGL Too High!
P17	DI19	MH6	1.00	22.49	22.49	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.49	7.08	HGL Too High!
P32	DI23	MH12	1.00	24.42	24.42	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.43	4.24	HGL Too High!
P31	DI9	MH12	1.00	24.42	24.42	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.42	7.13	HGL Too High!
P30	MH12	MH11	1.60	24.40	24.40	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	24.42	7.48	HGL Too High!
P27	MH11	MH10	1.60	24.33	24.33	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	24.40	7.21	HGL Too High!
P25	MH10	MH9	1.60	24.30	24.30	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	24.33	7.54	HGL Too High!
P22	MH9	MH8	1.60	24.25	24.25	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	24.30	7.85	HGL Too High!
P20	MH8	MH21	1.60	24.19	24.19	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	24.25	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	24.14	24.14	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	24.19	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	24.14	24.14	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	24.18	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	24.25	24.25	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	24.28	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	24.45	24.45	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	24.70	4.78	HGL Too High!
P51	STUB	DI22	1.00	24.45	24.45	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	24.49	7.16	HGL Too High!
P28	DI22	MH11	1.00	24.40	24.40	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	24.45	6.74	HGL Too High!
P29	DI8	MH11	1.00	24.40	24.40	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.40	6.92	HGL Too High!
P26	DI21	MH10	1.00	24.33	24.33	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.33	7.23	HGL Too High!
P23	DI20	MH9	1.00	24.30	24.30	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	24.31	7.38	HGL Too High!
P24	DI7	MH9	1.00	24.30	24.30	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.31	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	59.17	59.17	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	59.18	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	59.17	59.17	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	59.18	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	59.03	59.03	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	59.17	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	58.85	58.85	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	59.03	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	58.01	58.01	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	58.85	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	57.47	57.47	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	58.01	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	46.57	46.57	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	57.47	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	38.87	38.87	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	46.57	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	25.77	25.77	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	38.87	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	24.14	24.14	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	25.77	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	22.27	22.27	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	24.14	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	21.52	21.52	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	22.27	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.74	15.74	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	21.52	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.61	11.61	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	15.74	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.50**	**9.50**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	**0.5**	**0.59**	**2.11**	**11.61**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	60.89	60.89	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	68.70	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	60.89	60.89	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	60.92	6.45	HGL Too High!
P3	DI14	DI13	1.00	60.89	60.89	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	60.90	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	59.03	59.03	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	60.89	6.58	HGL Too High!
P2	DI2	DI1	1.00	58.86	58.86	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	58.86	6.84	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	58.85	58.85	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	58.86	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	60.85	60.85	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	60.87	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	60.85	60.85	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	62.02	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	57.47	57.47	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	60.85	8.13	HGL Too High!
P42	DI31	MH22	1.00	47.50	47.50	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	47.56	5.12	HGL Too High!
P43	MH22	DI32	1.00	47.45	47.45	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	47.50	5.45	HGL Too High!
P44	DI32	EX	1.00	46.57	46.57	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	47.45	5.23	HGL Too High!
P46	DI34	DI33	1.00	47.56	47.56	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	47.56	5.47	HGL Too High!
P45	DI33	DI32	1.00	47.45	47.45	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	47.56	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	25.77	25.77	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	25.77	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	57.86	57.86	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	58.03	3.63	HGL Too High!
P48	DI40	DI41	0.80	57.86	57.86	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	57.88	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	57.47	57.47	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	57.86	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	24.01	24.01	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.01	7.41	
P5	MH1	MH2	1.20	24.00	24.00	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	24.01	7.93	HGL Too High!
P7	MH2	MH3	1.20	23.98	23.98	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	24.00	7.65	HGL Too High!
P10	MH3	MH4	1.20	23.93	23.93	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	23.98	7.28	HGL Too High!
P13	MH4	MH5	1.20	23.77	23.77	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	23.93	7.09	HGL Too High!
P15	MH5	MH20	1.60	23.57	23.57	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	23.77	7.40	HGL Too High!
P6	DI16	MH2	1.00	24.00	24.00	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.00	7.33	HGL Too High!
P9	DI3	MH3	1.00	23.98	23.98	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.98	6.62	HGL Too High!
P8	DI17	MH3	1.00	23.98	23.98	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.98	6.96	HGL Too High!
P12	DI4	MH4	1.00	23.93	23.93	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.94	6.48	HGL Too High!
P11	DI18	MH4	1.00	23.93	23.93	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.94	6.56	HGL Too High!
P14	DI5	MH5	1.00	23.77	23.77	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.77	6.61	HGL Too High!
P18	DI6	MH6	1.00	23.79	23.79	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.80	7.13	HGL Too High!
P16	MH6	MH5	1.20	23.77	23.77	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	23.79	7.55	HGL Too High!
P17	DI19	MH6	1.00	23.79	23.79	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.79	7.08	HGL Too High!
P32	DI23	MH12	1.00	25.72	25.72	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.73	4.24	HGL Too High!
P31	DI9	MH12	1.00	25.72	25.72	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.72	7.13	HGL Too High!
P30	MH12	MH11	1.60	25.70	25.70	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	25.72	7.48	HGL Too High!
P27	MH11	MH10	1.60	25.63	25.63	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	25.70	7.21	HGL Too High!
P25	MH10	MH9	1.60	25.60	25.60	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	25.63	7.54	HGL Too High!
P22	MH9	MH8	1.60	25.55	25.55	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	25.60	7.85	HGL Too High!
P20	MH8	MH21	1.60	25.49	25.49	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	25.55	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	25.44	25.44	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	25.49	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	25.44	25.44	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	25.48	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	25.55	25.55	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	25.58	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	25.75	25.75	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	26.00	4.78	HGL Too High!
P51	STUB	DI22	1.00	25.75	25.75	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	25.79	7.16	HGL Too High!
P28	DI22	MH11	1.00	25.70	25.70	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	25.75	6.74	HGL Too High!
P29	DI8	MH11	1.00	25.70	25.70	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.70	6.92	HGL Too High!
P26	DI21	MH10	1.00	25.63	25.63	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.63	7.23	HGL Too High!
P23	DI20	MH9	1.00	25.60	25.60	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	25.61	7.38	HGL Too High!
P24	DI7	MH9	1.00	25.60	25.60	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.61	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	60.47	60.47	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	60.48	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	60.47	60.47	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	60.48	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	60.33	60.33	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	60.47	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	60.15	60.15	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	60.33	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	59.31	59.31	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	60.15	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	58.77	58.77	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	59.31	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	47.87	47.87	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	58.77	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	40.17	40.17	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	47.87	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	27.07	27.07	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	40.17	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	25.44	25.44	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	27.07	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	23.57	23.57	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	25.44	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	22.82	22.82	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	23.57	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	17.04	17.04	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	22.82	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.91	12.91	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	17.04	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.80**	**10.80**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	**0.5**	**0.59**	**2.11**	**12.91**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	62.19	62.19	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	70.00	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	62.19	62.19	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	62.22	6.45	HGL Too High!
P3	DI14	DI13	1.00	62.19	62.19	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	62.20	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	60.33	60.33	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	62.19	6.58	HGL Too High!
P2	DI2	DI1	1.00	60.16	60.16	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	60.16	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	60.15	60.15	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	60.16	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	62.15	62.15	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	62.17	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	62.15	62.15	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	63.32	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	58.77	58.77	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	62.15	8.13	HGL Too High!
P42	DI31	MH22	1.00	48.80	48.80	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	48.86	5.12	HGL Too High!
P43	MH22	DI32	1.00	48.75	48.75	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	48.80	5.45	HGL Too High!
P44	DI32	EX	1.00	47.87	47.87	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	48.75	5.23	HGL Too High!
P46	DI34	DI33	1.00	48.86	48.86	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	48.86	5.47	HGL Too High!
P45	DI33	DI32	1.00	48.75	48.75	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	48.86	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	27.07	27.07	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	27.07	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	59.16	59.16	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	59.33	3.63	HGL Too High!
P48	DI40	DI41	0.80	59.16	59.16	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	59.18	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	58.77	58.77	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	59.16	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	18.95	18.95	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.95	7.41	
P5	MH1	MH2	1.20	18.94	18.94	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	18.95	7.93	HGL Too High!
P7	MH2	MH3	1.20	18.92	18.92	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	18.94	7.65	HGL Too High!
P10	MH3	MH4	1.20	18.87	18.87	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	18.92	7.28	HGL Too High!
P13	MH4	MH5	1.20	18.71	18.71	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	18.87	7.09	HGL Too High!
P15	MH5	MH20	1.60	18.51	18.51	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	18.71	7.40	HGL Too High!
P6	DI16	MH2	1.00	18.94	18.94	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.94	7.33	HGL Too High!
P9	DI3	MH3	1.00	18.92	18.92	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.92	6.62	HGL Too High!
P8	DI17	MH3	1.00	18.92	18.92	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	18.92	6.96	HGL Too High!
P12	DI4	MH4	1.00	18.87	18.87	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.88	6.48	HGL Too High!
P11	DI18	MH4	1.00	18.87	18.87	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.88	6.56	HGL Too High!
P14	DI5	MH5	1.00	18.71	18.71	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.71	6.61	HGL Too High!
P18	DI6	MH6	1.00	18.73	18.73	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.74	7.13	HGL Too High!
P16	MH6	MH5	1.20	18.71	18.71	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	18.73	7.55	HGL Too High!
P17	DI19	MH6	1.00	18.73	18.73	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.73	7.08	HGL Too High!
P32	DI23	MH12	1.00	20.66	20.66	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.67	4.24	HGL Too High!
P31	DI9	MH12	1.00	20.66	20.66	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.66	7.13	HGL Too High!
P30	MH12	MH11	1.60	20.64	20.64	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	20.66	7.48	HGL Too High!
P27	MH11	MH10	1.60	20.57	20.57	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	20.64	7.21	HGL Too High!
P25	MH10	MH9	1.60	20.54	20.54	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	20.57	7.54	HGL Too High!
P22	MH9	MH8	1.60	20.49	20.49	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	20.54	7.85	HGL Too High!
P20	MH8	MH21	1.60	20.43	20.43	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	20.49	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	20.38	20.38	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	20.43	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	20.38	20.38	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	20.42	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	20.49	20.49	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	20.52	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	20.69	20.69	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	20.94	4.78	HGL Too High!
P51	STUB	DI22	1.00	20.69	20.69	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	20.73	7.16	HGL Too High!
P28	DI22	MH11	1.00	20.64	20.64	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	20.69	6.74	HGL Too High!
P29	DI8	MH11	1.00	20.64	20.64	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.64	6.92	HGL Too High!
P26	DI21	MH10	1.00	20.57	20.57	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.57	7.23	HGL Too High!
P23	DI20	MH9	1.00	20.54	20.54	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	20.55	7.38	HGL Too High!
P24	DI7	MH9	1.00	20.54	20.54	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.55	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	55.41	55.41	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	55.42	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	55.41	55.41	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	55.42	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	55.27	55.27	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	55.41	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	55.09	55.09	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	55.27	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	54.25	54.25	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	55.09	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	53.71	53.71	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	54.25	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	42.81	42.81	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	53.71	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	35.11	35.11	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	42.81	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	22.01	22.01	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	35.11	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	20.38	20.38	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	22.01	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	18.51	18.51	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	20.38	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	17.76	17.76	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	18.51	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	11.98	11.98	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	17.76	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	7.85	7.85	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	11.98	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.74**	**5.74**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	0.5	**0.59**	**2.11**	**7.85**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	57.13	57.13	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	64.94	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	57.13	57.13	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	57.16	6.45	HGL Too High!
P3	DI14	DI13	1.00	57.13	57.13	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	57.14	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	55.27	55.27	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	57.13	6.58	HGL Too High!
P2	DI2	DI1	1.00	55.10	55.10	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	55.10	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	55.09	55.09	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	55.10	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	57.09	57.09	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	57.11	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	57.09	57.09	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	58.26	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	53.71	53.71	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	57.09	8.13	HGL Too High!
P42	DI31	MH22	1.00	43.74	43.74	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	43.80	5.12	HGL Too High!
P43	MH22	DI32	1.00	43.69	43.69	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	43.74	5.45	HGL Too High!
P44	DI32	EX	1.00	42.81	42.81	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	43.69	5.23	HGL Too High!
P46	DI34	DI33	1.00	43.80	43.80	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	43.80	5.47	HGL Too High!
P45	DI33	DI32	1.00	43.69	43.69	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	43.80	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	22.01	22.01	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	22.01	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	54.10	54.10	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	54.27	3.63	HGL Too High!
P48	DI40	DI41	0.80	54.10	54.10	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	54.12	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	53.71	53.71	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	54.10	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	19.15	19.15	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.15	7.41	
P5	MH1	MH2	1.20	19.14	19.14	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	19.15	7.93	HGL Too High!
P7	MH2	MH3	1.20	19.12	19.12	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	19.14	7.65	HGL Too High!
P10	MH3	MH4	1.20	19.07	19.07	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	19.12	7.28	HGL Too High!
P13	MH4	MH5	1.20	18.91	18.91	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	19.07	7.09	HGL Too High!
P15	MH5	MH20	1.60	18.71	18.71	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	18.91	7.40	HGL Too High!
P6	DI16	MH2	1.00	19.14	19.14	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.14	7.33	HGL Too High!
P9	DI3	MH3	1.00	19.12	19.12	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.12	6.62	HGL Too High!
P8	DI17	MH3	1.00	19.12	19.12	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.12	6.96	HGL Too High!
P12	DI4	MH4	1.00	19.07	19.07	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.08	6.48	HGL Too High!
P11	DI18	MH4	1.00	19.07	19.07	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.08	6.56	HGL Too High!
P14	DI5	MH5	1.00	18.91	18.91	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.91	6.61	HGL Too High!
P18	DI6	MH6	1.00	18.93	18.93	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.94	7.13	HGL Too High!
P16	MH6	MH5	1.20	18.91	18.91	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	18.93	7.55	HGL Too High!
P17	DI19	MH6	1.00	18.93	18.93	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	18.93	7.08	HGL Too High!
P32	DI23	MH12	1.00	20.86	20.86	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	20.87	4.24	HGL Too High!
P31	DI9	MH12	1.00	20.86	20.86	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.86	7.13	HGL Too High!
P30	MH12	MH11	1.60	20.84	20.84	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	20.86	7.48	HGL Too High!
P27	MH11	MH10	1.60	20.77	20.77	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	20.84	7.21	HGL Too High!
P25	MH10	MH9	1.60	20.74	20.74	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	20.77	7.54	HGL Too High!
P22	MH9	MH8	1.60	20.69	20.69	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	20.74	7.85	HGL Too High!
P20	MH8	MH21	1.60	20.63	20.63	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	20.69	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	20.58	20.58	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	20.63	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	20.58	20.58	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	20.62	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	20.69	20.69	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	20.72	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	20.89	20.89	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	21.14	4.78	HGL Too High!
P51	STUB	DI22	1.00	20.89	20.89	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	20.93	7.16	HGL Too High!
P28	DI22	MH11	1.00	20.84	20.84	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	20.89	6.74	HGL Too High!
P29	DI8	MH11	1.00	20.84	20.84	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.84	6.92	HGL Too High!
P26	DI21	MH10	1.00	20.77	20.77	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.77	7.23	HGL Too High!
P23	DI20	MH9	1.00	20.74	20.74	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	20.75	7.38	HGL Too High!
P24	DI7	MH9	1.00	20.74	20.74	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	20.75	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	55.61	55.61	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	55.62	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	55.61	55.61	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	55.62	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	55.47	55.47	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	55.61	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	55.29	55.29	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	55.47	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	54.45	54.45	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	55.29	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	53.91	53.91	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	54.45	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	43.01	43.01	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	53.91	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	35.31	35.31	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	43.01	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	22.21	22.21	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	35.31	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	20.58	20.58	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	22.21	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	18.71	18.71	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	20.58	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	17.96	17.96	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	18.71	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.18	12.18	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	17.96	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	8.05	8.05	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	12.18	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.94**	**5.94**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	0.5	**0.59**	**2.11**	**8.05**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	57.33	57.33	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	65.14	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	57.33	57.33	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	57.36	6.45	HGL Too High!
P3	DI14	DI13	1.00	57.33	57.33	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	57.34	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	55.47	55.47	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	57.33	6.58	HGL Too High!
P2	DI2	DI1	1.00	55.30	55.30	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	55.30	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	55.29	55.29	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	55.30	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	57.29	57.29	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	57.31	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	57.29	57.29	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	58.46	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	53.91	53.91	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	57.29	8.13	HGL Too High!
P42	DI31	MH22	1.00	43.94	43.94	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	44.00	5.12	HGL Too High!
P43	MH22	DI32	1.00	43.89	43.89	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	43.94	5.45	HGL Too High!
P44	DI32	EX	1.00	43.01	43.01	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	43.89	5.23	HGL Too High!
P46	DI34	DI33	1.00	44.00	44.00	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	44.00	5.47	HGL Too High!
P45	DI33	DI32	1.00	43.89	43.89	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	44.00	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	22.21	22.21	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	22.21	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	54.30	54.30	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	54.47	3.63	HGL Too High!
P48	DI40	DI41	0.80	54.30	54.30	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	54.32	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	53.91	53.91	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	54.30	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	22.65	22.65	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.65	7.41	
P5	MH1	MH2	1.20	22.64	22.64	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	22.65	7.93	HGL Too High!
P7	MH2	MH3	1.20	22.62	22.62	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	22.64	7.65	HGL Too High!
P10	MH3	MH4	1.20	22.57	22.57	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	22.62	7.28	HGL Too High!
P13	MH4	MH5	1.20	22.41	22.41	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	22.57	7.09	HGL Too High!
P15	MH5	MH20	1.60	22.21	22.21	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	22.41	7.40	HGL Too High!
P6	DI16	MH2	1.00	22.64	22.64	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.64	7.33	HGL Too High!
P9	DI3	MH3	1.00	22.62	22.62	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.62	6.62	HGL Too High!
P8	DI17	MH3	1.00	22.62	22.62	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.62	6.96	HGL Too High!
P12	DI4	MH4	1.00	22.57	22.57	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.58	6.48	HGL Too High!
P11	DI18	MH4	1.00	22.57	22.57	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.58	6.56	HGL Too High!
P14	DI5	MH5	1.00	22.41	22.41	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.41	6.61	HGL Too High!
P18	DI6	MH6	1.00	22.43	22.43	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.44	7.13	HGL Too High!
P16	MH6	MH5	1.20	22.41	22.41	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	22.43	7.55	HGL Too High!
P17	DI19	MH6	1.00	22.43	22.43	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.43	7.08	HGL Too High!
P32	DI23	MH12	1.00	24.36	24.36	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.37	4.24	HGL Too High!
P31	DI9	MH12	1.00	24.36	24.36	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.36	7.13	HGL Too High!
P30	MH12	MH11	1.60	24.34	24.34	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	24.36	7.48	HGL Too High!
P27	MH11	MH10	1.60	24.27	24.27	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	24.34	7.21	HGL Too High!
P25	MH10	MH9	1.60	24.24	24.24	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	24.27	7.54	HGL Too High!
P22	MH9	MH8	1.60	24.19	24.19	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	24.24	7.85	HGL Too High!
P20	MH8	MH21	1.60	24.13	24.13	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	24.19	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	24.08	24.08	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	24.13	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	24.08	24.08	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	24.12	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	24.19	24.19	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	24.22	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	24.39	24.39	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	24.64	4.78	HGL Too High!
P51	STUB	DI22	1.00	24.39	24.39	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	24.43	7.16	HGL Too High!
P28	DI22	MH11	1.00	24.34	24.34	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	24.39	6.74	HGL Too High!
P29	DI8	MH11	1.00	24.34	24.34	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.34	6.92	HGL Too High!
P26	DI21	MH10	1.00	24.27	24.27	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.27	7.23	HGL Too High!
P23	DI20	MH9	1.00	24.24	24.24	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	24.25	7.38	HGL Too High!
P24	DI7	MH9	1.00	24.24	24.24	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.25	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	59.11	59.11	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	59.12	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	59.11	59.11	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	59.12	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	58.97	58.97	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	59.11	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	58.79	58.79	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	58.97	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	57.95	57.95	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	58.79	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	57.41	57.41	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	57.95	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	46.51	46.51	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	57.41	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	38.81	38.81	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	46.51	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	25.71	25.71	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	38.81	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	24.08	24.08	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	25.71	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	22.21	22.21	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	24.08	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	21.46	21.46	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	22.21	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.68	15.68	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	21.46	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.55	11.55	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	15.68	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.44**	**9.44**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	**0.5**	**0.59**	**2.11**	**11.55**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	60.83	60.83	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	68.64	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	60.83	60.83	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	60.86	6.45	HGL Too High!
P3	DI14	DI13	1.00	60.83	60.83	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	60.84	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	58.97	58.97	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	60.83	6.58	HGL Too High!
P2	DI2	DI1	1.00	58.80	58.80	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	58.80	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	58.79	58.79	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	58.80	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	60.79	60.79	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	60.81	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	60.79	60.79	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	61.96	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	57.41	57.41	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	60.79	8.13	HGL Too High!
P42	DI31	MH22	1.00	47.44	47.44	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	47.50	5.12	HGL Too High!
P43	MH22	DI32	1.00	47.39	47.39	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	47.44	5.45	HGL Too High!
P44	DI32	EX	1.00	46.51	46.51	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	47.39	5.23	HGL Too High!
P46	DI34	DI33	1.00	47.50	47.50	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	47.50	5.47	HGL Too High!
P45	DI33	DI32	1.00	47.39	47.39	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	47.50	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	25.71	25.71	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	25.71	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	57.80	57.80	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	57.97	3.63	HGL Too High!
P48	DI40	DI41	0.80	57.80	57.80	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	57.82	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	57.41	57.41	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	57.80	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	23.15	23.15	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.15	7.41	
P5	MH1	MH2	1.20	23.14	23.14	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	23.15	7.93	HGL Too High!
P7	MH2	MH3	1.20	23.12	23.12	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	23.14	7.65	HGL Too High!
P10	MH3	MH4	1.20	23.07	23.07	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	23.12	7.28	HGL Too High!
P13	MH4	MH5	1.20	22.91	22.91	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	23.07	7.09	HGL Too High!
P15	MH5	MH20	1.60	22.71	22.71	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	22.91	7.40	HGL Too High!
P6	DI16	MH2	1.00	23.14	23.14	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.14	7.33	HGL Too High!
P9	DI3	MH3	1.00	23.12	23.12	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.12	6.62	HGL Too High!
P8	DI17	MH3	1.00	23.12	23.12	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.12	6.96	HGL Too High!
P12	DI4	MH4	1.00	23.07	23.07	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.08	6.48	HGL Too High!
P11	DI18	MH4	1.00	23.07	23.07	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.08	6.56	HGL Too High!
P14	DI5	MH5	1.00	22.91	22.91	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.91	6.61	HGL Too High!
P18	DI6	MH6	1.00	22.93	22.93	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.94	7.13	HGL Too High!
P16	MH6	MH5	1.20	22.91	22.91	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	22.93	7.55	HGL Too High!
P17	DI19	MH6	1.00	22.93	22.93	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.93	7.08	HGL Too High!
P32	DI23	MH12	1.00	24.86	24.86	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.87	4.24	HGL Too High!
P31	DI9	MH12	1.00	24.86	24.86	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.86	7.13	HGL Too High!
P30	MH12	MH11	1.60	24.84	24.84	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	24.86	7.48	HGL Too High!
P27	MH11	MH10	1.60	24.77	24.77	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	24.84	7.21	HGL Too High!
P25	MH10	MH9	1.60	24.74	24.74	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	24.77	7.54	HGL Too High!
P22	MH9	MH8	1.60	24.69	24.69	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	24.74	7.85	HGL Too High!
P20	MH8	MH21	1.60	24.63	24.63	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	24.69	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	24.58	24.58	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	24.63	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	24.58	24.58	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	24.62	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	24.69	24.69	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	24.72	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	24.89	24.89	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	25.14	4.78	HGL Too High!
P51	STUB	DI22	1.00	24.89	24.89	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	24.93	7.16	HGL Too High!
P28	DI22	MH11	1.00	24.84	24.84	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	24.89	6.74	HGL Too High!
P29	DI8	MH11	1.00	24.84	24.84	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.84	6.92	HGL Too High!
P26	DI21	MH10	1.00	24.77	24.77	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.77	7.23	HGL Too High!
P23	DI20	MH9	1.00	24.74	24.74	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	24.75	7.38	HGL Too High!
P24	DI7	MH9	1.00	24.74	24.74	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.75	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	59.61	59.61	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	59.62	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	59.61	59.61	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	59.62	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	59.47	59.47	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	59.61	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	59.29	59.29	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	59.47	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	58.45	58.45	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	59.29	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	57.91	57.91	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	58.45	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	47.01	47.01	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	57.91	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	39.31	39.31	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	47.01	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	26.21	26.21	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	39.31	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	24.58	24.58	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	26.21	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	22.71	22.71	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	24.58	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	21.96	21.96	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	22.71	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	16.18	16.18	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	21.96	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.05	12.05	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	16.18	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.94**	**9.94**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	**0.5**	**0.59**	**2.11**	**12.05**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	61.33	61.33	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	69.14	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	61.33	61.33	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	61.36	6.45	HGL Too High!
P3	DI14	DI13	1.00	61.33	61.33	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	61.34	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	59.47	59.47	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	61.33	6.58	HGL Too High!
P2	DI2	DI1	1.00	59.30	59.30	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	59.30	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	59.29	59.29	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	59.30	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	61.29	61.29	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	61.31	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	61.29	61.29	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	62.46	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	57.91	57.91	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	61.29	8.13	HGL Too High!
P42	DI31	MH22	1.00	47.94	47.94	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	48.00	5.12	HGL Too High!
P43	MH22	DI32	1.00	47.89	47.89	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	47.94	5.45	HGL Too High!
P44	DI32	EX	1.00	47.01	47.01	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	47.89	5.23	HGL Too High!
P46	DI34	DI33	1.00	48.00	48.00	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	48.00	5.47	HGL Too High!
P45	DI33	DI32	1.00	47.89	47.89	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	48.00	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	26.21	26.21	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	26.21	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	58.30	58.30	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	58.47	3.63	HGL Too High!
P48	DI40	DI41	0.80	58.30	58.30	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	58.32	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	57.91	57.91	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	58.30	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	23.55	23.55	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.55	7.41	
P5	MH1	MH2	1.20	23.54	23.54	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	23.55	7.93	HGL Too High!
P7	MH2	MH3	1.20	23.52	23.52	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	23.54	7.65	HGL Too High!
P10	MH3	MH4	1.20	23.47	23.47	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	23.52	7.28	HGL Too High!
P13	MH4	MH5	1.20	23.31	23.31	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	23.47	7.09	HGL Too High!
P15	MH5	MH20	1.60	23.11	23.11	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	23.31	7.40	HGL Too High!
P6	DI16	MH2	1.00	23.54	23.54	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.54	7.33	HGL Too High!
P9	DI3	MH3	1.00	23.52	23.52	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.52	6.62	HGL Too High!
P8	DI17	MH3	1.00	23.52	23.52	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.52	6.96	HGL Too High!
P12	DI4	MH4	1.00	23.47	23.47	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.48	6.48	HGL Too High!
P11	DI18	MH4	1.00	23.47	23.47	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.48	6.56	HGL Too High!
P14	DI5	MH5	1.00	23.31	23.31	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.31	6.61	HGL Too High!
P18	DI6	MH6	1.00	23.33	23.33	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.34	7.13	HGL Too High!
P16	MH6	MH5	1.20	23.31	23.31	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	23.33	7.55	HGL Too High!
P17	DI19	MH6	1.00	23.33	23.33	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.33	7.08	HGL Too High!
P32	DI23	MH12	1.00	25.26	25.26	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.27	4.24	HGL Too High!
P31	DI9	MH12	1.00	25.26	25.26	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.26	7.13	HGL Too High!
P30	MH12	MH11	1.60	25.24	25.24	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	25.26	7.48	HGL Too High!
P27	MH11	MH10	1.60	25.17	25.17	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	25.24	7.21	HGL Too High!
P25	MH10	MH9	1.60	25.14	25.14	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	25.17	7.54	HGL Too High!
P22	MH9	MH8	1.60	25.09	25.09	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	25.14	7.85	HGL Too High!
P20	MH8	MH21	1.60	25.03	25.03	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	25.09	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	24.98	24.98	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	25.03	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	24.98	24.98	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	25.02	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	25.09	25.09	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	25.12	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	25.29	25.29	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	25.54	4.78	HGL Too High!
P51	STUB	DI22	1.00	25.29	25.29	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	25.33	7.16	HGL Too High!
P28	DI22	MH11	1.00	25.24	25.24	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	25.29	6.74	HGL Too High!
P29	DI8	MH11	1.00	25.24	25.24	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.24	6.92	HGL Too High!
P26	DI21	MH10	1.00	25.17	25.17	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.17	7.23	HGL Too High!
P23	DI20	MH9	1.00	25.14	25.14	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	25.15	7.38	HGL Too High!
P24	DI7	MH9	1.00	25.14	25.14	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.15	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	60.01	60.01	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	60.02	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	60.01	60.01	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	60.02	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	59.87	59.87	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	60.01	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	59.69	59.69	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	59.87	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	58.85	58.85	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	59.69	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	58.31	58.31	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	58.85	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	47.41	47.41	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	58.31	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	39.71	39.71	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	47.41	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	26.61	26.61	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	39.71	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	24.98	24.98	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	26.61	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	23.11	23.11	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	24.98	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	22.36	22.36	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	23.11	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	16.58	16.58	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	22.36	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.45	12.45	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	16.58	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.34**	**10.34**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	**0.5**	**0.59**	**2.11**	**12.45**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	61.73	61.73	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	69.54	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	61.73	61.73	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	61.76	6.45	HGL Too High!
P3	DI14	DI13	1.00	61.73	61.73	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	61.74	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	59.87	59.87	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	61.73	6.58	HGL Too High!
P2	DI2	DI1	1.00	59.70	59.70	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	59.70	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	59.69	59.69	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	59.70	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	61.69	61.69	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	61.71	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	61.69	61.69	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	62.86	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	58.31	58.31	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	61.69	8.13	HGL Too High!
P42	DI31	MH22	1.00	48.34	48.34	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	48.40	5.12	HGL Too High!
P43	MH22	DI32	1.00	48.29	48.29	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	48.34	5.45	HGL Too High!
P44	DI32	EX	1.00	47.41	47.41	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	48.29	5.23	HGL Too High!
P46	DI34	DI33	1.00	48.40	48.40	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	48.40	5.47	HGL Too High!
P45	DI33	DI32	1.00	48.29	48.29	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	48.40	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	26.61	26.61	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	26.61	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	58.70	58.70	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	58.87	3.63	HGL Too High!
P48	DI40	DI41	0.80	58.70	58.70	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	58.72	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	58.31	58.31	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	58.70	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	24.05	24.05	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.05	7.41	
P5	MH1	MH2	1.20	24.04	24.04	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	24.05	7.93	HGL Too High!
P7	MH2	MH3	1.20	24.02	24.02	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	24.04	7.65	HGL Too High!
P10	MH3	MH4	1.20	23.97	23.97	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	24.02	7.28	HGL Too High!
P13	MH4	MH5	1.20	23.81	23.81	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	23.97	7.09	HGL Too High!
P15	MH5	MH20	1.60	23.61	23.61	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	23.81	7.40	HGL Too High!
P6	DI16	MH2	1.00	24.04	24.04	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.04	7.33	HGL Too High!
P9	DI3	MH3	1.00	24.02	24.02	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.02	6.62	HGL Too High!
P8	DI17	MH3	1.00	24.02	24.02	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.02	6.96	HGL Too High!
P12	DI4	MH4	1.00	23.97	23.97	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.98	6.48	HGL Too High!
P11	DI18	MH4	1.00	23.97	23.97	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.98	6.56	HGL Too High!
P14	DI5	MH5	1.00	23.81	23.81	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.81	6.61	HGL Too High!
P18	DI6	MH6	1.00	23.83	23.83	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.84	7.13	HGL Too High!
P16	MH6	MH5	1.20	23.81	23.81	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	23.83	7.55	HGL Too High!
P17	DI19	MH6	1.00	23.83	23.83	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.83	7.08	HGL Too High!
P32	DI23	MH12	1.00	25.76	25.76	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.77	4.24	HGL Too High!
P31	DI9	MH12	1.00	25.76	25.76	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.76	7.13	HGL Too High!
P30	MH12	MH11	1.60	25.74	25.74	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	25.76	7.48	HGL Too High!
P27	MH11	MH10	1.60	25.67	25.67	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	25.74	7.21	HGL Too High!
P25	MH10	MH9	1.60	25.64	25.64	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	25.67	7.54	HGL Too High!
P22	MH9	MH8	1.60	25.59	25.59	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	25.64	7.85	HGL Too High!
P20	MH8	MH21	1.60	25.53	25.53	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	25.59	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	25.48	25.48	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	25.53	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	25.48	25.48	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	25.52	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	25.59	25.59	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	25.62	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	25.79	25.79	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	26.04	4.78	HGL Too High!
P51	STUB	DI22	1.00	25.79	25.79	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	25.83	7.16	HGL Too High!
P28	DI22	MH11	1.00	25.74	25.74	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	25.79	6.74	HGL Too High!
P29	DI8	MH11	1.00	25.74	25.74	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.74	6.92	HGL Too High!
P26	DI21	MH10	1.00	25.67	25.67	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.67	7.23	HGL Too High!
P23	DI20	MH9	1.00	25.64	25.64	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	25.65	7.38	HGL Too High!
P24	DI7	MH9	1.00	25.64	25.64	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.65	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	60.51	60.51	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	60.52	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	60.51	60.51	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	60.52	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	60.37	60.37	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	60.51	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	60.19	60.19	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	60.37	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	59.35	59.35	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	60.19	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	58.81	58.81	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	59.35	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	47.91	47.91	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	58.81	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	40.21	40.21	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	47.91	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	27.11	27.11	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	40.21	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	25.48	25.48	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	27.11	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	23.61	23.61	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	25.48	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	22.86	22.86	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	23.61	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	17.08	17.08	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	22.86	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.95	12.95	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	17.08	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.84**	**10.84**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	**0.5**	**0.59**	**2.11**	**12.95**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	62.23	62.23	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	70.04	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	62.23	62.23	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	62.26	6.45	HGL Too High!
P3	DI14	DI13	1.00	62.23	62.23	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	62.24	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	60.37	60.37	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	62.23	6.58	HGL Too High!
P2	DI2	DI1	1.00	60.20	60.20	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	60.20	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	60.19	60.19	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	60.20	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	62.19	62.19	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	62.21	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	62.19	62.19	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	63.36	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	58.81	58.81	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	62.19	8.13	HGL Too High!
P42	DI31	MH22	1.00	48.84	48.84	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	48.90	5.12	HGL Too High!
P43	MH22	DI32	1.00	48.79	48.79	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	48.84	5.45	HGL Too High!
P44	DI32	EX	1.00	47.91	47.91	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	48.79	5.23	HGL Too High!
P46	DI34	DI33	1.00	48.90	48.90	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	48.90	5.47	HGL Too High!
P45	DI33	DI32	1.00	48.79	48.79	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	48.90	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	27.11	27.11	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	27.11	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	59.20	59.20	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	59.37	3.63	HGL Too High!
P48	DI40	DI41	0.80	59.20	59.20	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	59.22	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	58.81	58.81	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	59.20	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	24.75	24.75	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.75	7.41	
P5	MH1	MH2	1.20	24.74	24.74	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	24.75	7.93	HGL Too High!
P7	MH2	MH3	1.20	24.72	24.72	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	24.74	7.65	HGL Too High!
P10	MH3	MH4	1.20	24.67	24.67	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	24.72	7.28	HGL Too High!
P13	MH4	MH5	1.20	24.51	24.51	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	24.67	7.09	HGL Too High!
P15	MH5	MH20	1.60	24.31	24.31	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	24.51	7.40	HGL Too High!
P6	DI16	MH2	1.00	24.74	24.74	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.74	7.33	HGL Too High!
P9	DI3	MH3	1.00	24.72	24.72	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.72	6.62	HGL Too High!
P8	DI17	MH3	1.00	24.72	24.72	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.72	6.96	HGL Too High!
P12	DI4	MH4	1.00	24.67	24.67	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.68	6.48	HGL Too High!
P11	DI18	MH4	1.00	24.67	24.67	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.68	6.56	HGL Too High!
P14	DI5	MH5	1.00	24.51	24.51	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.51	6.61	HGL Too High!
P18	DI6	MH6	1.00	24.53	24.53	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.54	7.13	HGL Too High!
P16	MH6	MH5	1.20	24.51	24.51	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	24.53	7.55	HGL Too High!
P17	DI19	MH6	1.00	24.53	24.53	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.53	7.08	HGL Too High!
P32	DI23	MH12	1.00	26.46	26.46	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.47	4.24	HGL Too High!
P31	DI9	MH12	1.00	26.46	26.46	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.46	7.13	HGL Too High!
P30	MH12	MH11	1.60	26.44	26.44	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	26.46	7.48	HGL Too High!
P27	MH11	MH10	1.60	26.37	26.37	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	26.44	7.21	HGL Too High!
P25	MH10	MH9	1.60	26.34	26.34	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	26.37	7.54	HGL Too High!
P22	MH9	MH8	1.60	26.29	26.29	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	26.34	7.85	HGL Too High!
P20	MH8	MH21	1.60	26.23	26.23	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	26.29	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	26.18	26.18	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	26.23	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	26.18	26.18	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	26.22	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	26.29	26.29	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	26.32	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	26.49	26.49	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	26.74	4.78	HGL Too High!
P51	STUB	DI22	1.00	26.49	26.49	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	26.53	7.16	HGL Too High!
P28	DI22	MH11	1.00	26.44	26.44	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	26.49	6.74	HGL Too High!
P29	DI8	MH11	1.00	26.44	26.44	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.44	6.92	HGL Too High!
P26	DI21	MH10	1.00	26.37	26.37	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.37	7.23	HGL Too High!
P23	DI20	MH9	1.00	26.34	26.34	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	26.35	7.38	HGL Too High!
P24	DI7	MH9	1.00	26.34	26.34	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.35	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	61.21	61.21	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	61.22	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	61.21	61.21	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	61.22	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	61.07	61.07	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	61.21	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	60.89	60.89	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	61.07	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	60.05	60.05	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	60.89	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	59.51	59.51	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	60.05	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	48.61	48.61	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	59.51	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	40.91	40.91	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	48.61	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	27.81	27.81	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	40.91	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	26.18	26.18	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	27.81	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	24.31	24.31	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	26.18	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	23.56	23.56	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	24.31	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	17.78	17.78	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	23.56	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.65	13.65	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	17.78	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**11.54**	**11.54**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	0.5	**0.59**	**2.11**	**13.65**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	62.93	62.93	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	70.74	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	62.93	62.93	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	62.96	6.45	HGL Too High!
P3	DI14	DI13	1.00	62.93	62.93	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	62.94	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	61.07	61.07	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	62.93	6.58	HGL Too High!
P2	DI2	DI1	1.00	60.90	60.90	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	60.90	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	60.89	60.89	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	60.90	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	62.89	62.89	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	62.91	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	62.89	62.89	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	64.06	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	59.51	59.51	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	62.89	8.13	HGL Too High!
P42	DI31	MH22	1.00	49.54	49.54	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	49.60	5.12	HGL Too High!
P43	MH22	DI32	1.00	49.49	49.49	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	49.54	5.45	HGL Too High!
P44	DI32	EX	1.00	48.61	48.61	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	49.49	5.23	HGL Too High!
P46	DI34	DI33	1.00	49.60	49.60	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	49.60	5.47	HGL Too High!
P45	DI33	DI32	1.00	49.49	49.49	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	49.60	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	27.81	27.81	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	27.81	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	59.90	59.90	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	60.07	3.63	HGL Too High!
P48	DI40	DI41	0.80	59.90	59.90	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	59.92	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	59.51	59.51	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	59.90	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	25.25	25.25	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.25	7.41	
P5	MH1	MH2	1.20	25.24	25.24	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	25.25	7.93	HGL Too High!
P7	MH2	MH3	1.20	25.22	25.22	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	25.24	7.65	HGL Too High!
P10	MH3	MH4	1.20	25.17	25.17	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	25.22	7.28	HGL Too High!
P13	MH4	MH5	1.20	25.01	25.01	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	25.17	7.09	HGL Too High!
P15	MH5	MH20	1.60	24.81	24.81	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	25.01	7.40	HGL Too High!
P6	DI16	MH2	1.00	25.24	25.24	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.24	7.33	HGL Too High!
P9	DI3	MH3	1.00	25.22	25.22	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.22	6.62	HGL Too High!
P8	DI17	MH3	1.00	25.22	25.22	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.22	6.96	HGL Too High!
P12	DI4	MH4	1.00	25.17	25.17	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.18	6.48	HGL Too High!
P11	DI18	MH4	1.00	25.17	25.17	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.18	6.56	HGL Too High!
P14	DI5	MH5	1.00	25.01	25.01	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.01	6.61	HGL Too High!
P18	DI6	MH6	1.00	25.03	25.03	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.04	7.13	HGL Too High!
P16	MH6	MH5	1.20	25.01	25.01	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	25.03	7.55	HGL Too High!
P17	DI19	MH6	1.00	25.03	25.03	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.03	7.08	HGL Too High!
P32	DI23	MH12	1.00	26.96	26.96	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.97	4.24	HGL Too High!
P31	DI9	MH12	1.00	26.96	26.96	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.96	7.13	HGL Too High!
P30	MH12	MH11	1.60	26.94	26.94	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	26.96	7.48	HGL Too High!
P27	MH11	MH10	1.60	26.87	26.87	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	26.94	7.21	HGL Too High!
P25	MH10	MH9	1.60	26.84	26.84	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	26.87	7.54	HGL Too High!
P22	MH9	MH8	1.60	26.79	26.79	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	26.84	7.85	HGL Too High!
P20	MH8	MH21	1.60	26.73	26.73	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	26.79	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	26.68	26.68	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	26.73	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	26.68	26.68	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	26.72	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	26.79	26.79	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	26.82	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	26.99	26.99	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	27.24	4.78	HGL Too High!
P51	STUB	DI22	1.00	26.99	26.99	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	27.03	7.16	HGL Too High!
P28	DI22	MH11	1.00	26.94	26.94	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	26.99	6.74	HGL Too High!
P29	DI8	MH11	1.00	26.94	26.94	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.94	6.92	HGL Too High!
P26	DI21	MH10	1.00	26.87	26.87	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.87	7.23	HGL Too High!
P23	DI20	MH9	1.00	26.84	26.84	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	26.85	7.38	HGL Too High!
P24	DI7	MH9	1.00	26.84	26.84	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.85	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	61.71	61.71	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	61.72	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	61.71	61.71	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	61.72	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	61.57	61.57	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	61.71	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	61.39	61.39	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	61.57	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	60.55	60.55	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	61.39	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	60.01	60.01	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	60.55	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	49.11	49.11	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	60.01	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	41.41	41.41	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	49.11	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	28.31	28.31	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	41.41	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	26.68	26.68	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	28.31	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	24.81	24.81	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	26.68	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	24.06	24.06	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	24.81	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	18.28	18.28	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	24.06	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	14.15	14.15	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	18.28	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**12.04**	**12.04**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	**0.5**	**0.59**	**2.11**	**14.15**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	63.43	63.43	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	71.24	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	63.43	63.43	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	63.46	6.45	HGL Too High!
P3	DI14	DI13	1.00	63.43	63.43	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	63.44	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	61.57	61.57	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	63.43	6.58	HGL Too High!
P2	DI2	DI1	1.00	61.40	61.40	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	61.40	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	61.39	61.39	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	61.40	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	63.39	63.39	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	63.41	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	63.39	63.39	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	64.56	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	60.01	60.01	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	63.39	8.13	HGL Too High!
P42	DI31	MH22	1.00	50.04	50.04	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	50.10	5.12	HGL Too High!
P43	MH22	DI32	1.00	49.99	49.99	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	50.04	5.45	HGL Too High!
P44	DI32	EX	1.00	49.11	49.11	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	49.99	5.23	HGL Too High!
P46	DI34	DI33	1.00	50.10	50.10	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	50.10	5.47	HGL Too High!
P45	DI33	DI32	1.00	49.99	49.99	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	50.10	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	28.31	28.31	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	28.31	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	60.40	60.40	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	60.57	3.63	HGL Too High!
P48	DI40	DI41	0.80	60.40	60.40	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	60.42	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	60.01	60.01	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	60.40	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	26.55	26.55	15	0.6	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.55	7.41	
P5	MH1	MH2	1.20	26.54	26.54	18	1.2	0.7	0	82.7	0.0001	0.01	0	0.00	0.00	0.3	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.01	26.55	7.93	HGL Too High!
P7	MH2	MH3	1.20	26.52	26.52	18	1.7	1.0	1	73.8	0.0002	0.02	0	0.00	0.00	0.8	0.3	0.0	0.7	0.0	0	0.00	0.01	1.0	0.5	0.00	0.02	26.54	7.65	HGL Too High!
P10	MH3	MH4	1.20	26.47	26.47	18	3.1	1.8	8	53.7	0.0007	0.04	0	0.00	0.01	1.7	0.5	0.4	1.0	0.0	1	0.00	0.02	1.0	0.5	0.01	0.05	26.52	7.28	HGL Too High!
P13	MH4	MH5	1.20	26.31	26.31	18	5.3	3.0	84	59.3	0.0022	0.13	0	0.00	0.04	5.5	1.2	1.0	1.8	0.0	8	0.00	0.06	1.0	0.5	0.03	0.16	26.47	7.09	HGL Too High!
P15	MH5	MH20	1.60	26.11	26.11	24	8.0	2.5	90	104	0.0011	0.11	0	0.00	0.03	16.1	2.2	0.7	3.0	0.0	84	0.10	0.17	1.0	0.5	0.09	0.20	26.31	7.40	HGL Too High!
P6	DI16	MH2	1.00	26.54	26.54	15	0.6	0.5	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.54	7.33	HGL Too High!
P9	DI3	MH3	1.00	26.52	26.52	15	0.8	0.6	87	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.52	6.62	HGL Too High!
P8	DI17	MH3	1.00	26.52	26.52	15	0.7	0.6	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.52	6.96	HGL Too High!
P12	DI4	MH4	1.00	26.47	26.47	15	1.2	1.0	99	20.1	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.48	6.48	HGL Too High!
P11	DI18	MH4	1.00	26.47	26.47	15	1.1	0.9	86	28.4	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.48	6.56	HGL Too High!
P14	DI5	MH5	1.00	26.31	26.31	15	0.9	0.7	21	22.6	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.31	6.61	HGL Too High!
P18	DI6	MH6	1.00	26.33	26.33	15	1.2	1.0	23	38	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.34	7.13	HGL Too High!
P16	MH6	MH5	1.20	26.31	26.31	18	2.0	1.1	86	40	0.0003	0.01	0	0.00	0.00	1.2	0.5	0.0	1.0	0.0	23	0.00	0.01	1.0	0.5	0.01	0.02	26.33	7.55	HGL Too High!
P17	DI19	MH6	1.00	26.33	26.33	15	0.8	0.7	94	33	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.33	7.08	HGL Too High!
P32	DI23	MH12	1.00	28.26	28.26	15	1.0	0.8	64	33.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.27	4.24	HGL Too High!
P31	DI9	MH12	1.00	28.26	28.26	15	0.8	0.6	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.26	7.13	HGL Too High!
P30	MH12	MH11	1.60	28.24	28.24	24	1.7	0.5	1	50.1	0.0002	0.01	0	0.00	0.00	0.5	0.8	0.0	0.8	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	28.26	7.48	HGL Too High!
P27	MH11	MH10	1.60	28.17	28.17	24	3.5	1.1	5	73.2	0.0009	0.07	0	0.00	0.00	0.9	0.8	0.6	0.5	0.0	1	0.00	0.01	1.0	0.5	0.00	0.07	28.24	7.21	HGL Too High!
P25	MH10	MH9	1.60	28.14	28.14	24	3.9	1.2	5	69.7	0.0003	0.02	0	0.00	0.01	3.9	0.2	0.0	1.1	0.0	5	0.00	0.01	1.0	0.5	0.01	0.02	28.17	7.54	HGL Too High!
P22	MH9	MH8	1.60	28.09	28.09	24	4.9	1.6	51	108	0.0004	0.04	0	0.00	0.01	4.9	0.3	0.2	1.2	0.0	5	0.00	0.02	1.0	0.5	0.01	0.05	28.14	7.85	HGL Too High!
P20	MH8	MH21	1.60	28.03	28.03	24	6.3	2.0	90	57.3	0.0007	0.04	0	0.00	0.02	7.7	2.0	0.0	1.6	0.0	51	0.02	0.05	1.0	0.5	0.02	0.06	28.09	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	27.98	27.98	24	6.3	2.0	21	11.3	0.0007	0.01	0	0.00	0.02	12.7	0.0	0.0	2.0	0.0	90	0.04	0.08	1.0	0.5	0.04	0.05	28.03	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	27.98	27.98	18	4.7	2.7	35	7.75	0.0017	0.01	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.04	28.02	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	28.09	28.09	15	1.6	1.3	35	49	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.03	28.12	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	28.29	28.29	8	1.4	4.0	45	17	0.0112	0.19	0	0.00	0.06	0.0	0.0	0.0	0.0	0.0	0	0.00	0.06	1.0	1.0	0.06	0.25	28.54	4.78	HGL Too High!
P51	STUB	DI22	1.00	28.29	28.29	15	3.3	2.7	0	10	0.0023	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.01	0.04	28.33	7.16	HGL Too High!
P28	DI22	MH11	1.00	28.24	28.24	15	1.0	0.8	90	30.3	0.0002	0.01	0	0.00	0.00	9.1	5.5	0.0	2.7	0.0	0	0.00	0.04	1.0	1.0	0.04	0.05	28.29	6.74	HGL Too High!
P29	DI8	MH11	1.00	28.24	28.24	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.24	6.92	HGL Too High!
P26	DI21	MH10	1.00	28.17	28.17	15	0.5	0.4	93	18.3	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.17	7.23	HGL Too High!
P23	DI20	MH9	1.00	28.14	28.14	15	0.6	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	28.15	7.38	HGL Too High!
P24	DI7	MH9	1.00	28.14	28.14	15	0.5	0.4	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.15	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	63.01	63.01	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	63.02	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	63.01	63.01	15	1.1	0.9	90	34	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	63.02	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	62.87	62.87	15	2.0	1.7	90	154	0.0009	0.13	0	0.00	0.01	0.7	1.0	0.0	0.9	0.0	90	0.01	0.02	1.0	0.5	0.01	0.14	63.01	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	62.69	62.69	15	4.9	4.0	90	23	0.0058	0.13	0	0.00	0.06	3.4	7.4	0.0	2.5	0.0	0	0.00	0.10	1.0	0.5	0.05	0.18	62.87	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	61.85	61.85	15	5.9	4.8	0	78	0.0084	0.66	0	0.00	0.09	19.8	0.9	0.0	4.0	0.1	90	0.18	0.35	1.0	0.5	0.18	0.84	62.69	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	61.31	61.31	15	5.8	4.7	0	54	0.0080	0.43	0	0.00	0.09	28.7	0.0	0.0	4.8	0.1	0	0.00	0.21	1.0	0.5	0.11	0.54	61.85	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	50.41	50.41	15	12.7	10.3	0	263	0.0386	10.16	0	0.00	0.42	27.2	35.8	12.1	8.1	0.4	90	0.71	1.49	1.0	0.5	0.74	10.90	61.31	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	42.71	42.71	15	17.5	14.2	0	96	0.0731	7.02	0	0.00	0.79	131.3	40.1	0.0	10.3	0.6	0	0.00	1.37	1.0	0.5	0.68	7.71	50.41	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	29.61	29.61	15	17.0	13.9	60	175	0.0696	12.17	0	0.00	0.75	248.7	0.0	0.0	14.2	1.1	0	0.00	1.85	1.0	0.5	0.92	13.10	42.71	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	27.98	27.98	24	16.3	5.2	84	41	0.0052	0.21	0	0.00	0.10	236.6	0.0	0.0	13.9	1.0	60	1.68	2.83	1.0	0.5	1.41	1.63	29.61	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	26.11	26.11	24	25.1	8.0	13	124	0.0123	1.53	0	0.00	0.25	84.9	12.6	12.5	5.2	0.1	84	0.29	0.68	1.0	0.5	0.34	1.87	27.98	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	25.36	25.36	24	31.3	9.9	78	8	0.0191	0.15	0	0.00	0.38	200.5	0.0	0.0	8.0	0.3	13	0.19	0.92	1.3	0.5	0.60	0.75	26.11	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	19.58	19.58	24	31.3	9.9	0	252	0.0191	4.81	0	0.00	0.38	311.0	0.0	0.0	9.9	0.5	78	1.01	1.94	1.0	0.5	0.97	5.78	25.36	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	15.45	15.45	24	29.3	9.3	25	221	0.0167	3.70	0	0.00	0.34	311.0	0.0	0.0	9.9	0.5	0	0.00	0.87	1.0	0.5	0.44	4.13	19.58	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**13.34**	**13.34**	**24**	**28.1**	**9.0**	**0**	**98**	**0.0155**	**1.52**	**0**	**0.00**	**0.31**	**272.5**	**0.0**	**0.0**	**9.3**	**0.5**	**25**	**0.40**	**1.19**	**1.0**	**0.5**	**0.59**	**2.11**	**15.45**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	64.73	64.73	4	1.4	16.0	0	16	0.4569	7.31	0	0.00	0.99	0.0	0.0	0.0	0.0	0.0	0	0.00	0.99	1.0	0.5	0.49	7.81	72.54	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	64.73	64.73	8	0.4	1.1	90	33	0.0007	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	64.76	6.45	HGL Too High!
P3	DI14	DI13	1.00	64.73	64.73	15	0.6	0.5	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	64.74	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	62.87	62.87	15	3.0	2.5	0	15	0.0022	0.03	0	0.00	0.02	0.3	22.3	0.4	16.0	1.4	0	0.00	1.41	1.3	1.0	1.83	1.86	64.73	6.58	HGL Too High!
P2	DI2	DI1	1.00	62.70	62.70	15	0.7	0.5	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	62.70	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	25	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Q, V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	62.69	62.69	15	1.1	0.9	111	3.34	0.0002	0.00	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	62.70	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	64.69	64.69	8	0.3	0.7	104	46	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	64.71	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	64.69	64.69	12	4.3	5.4	90	87	0.0121	1.06	0	0.00	0.11	0.0	0.0	0.0	0.0	0.0	0	0.00	0.11	1.0	1.0	0.11	1.17	65.86	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	61.31	61.31	10	4.4	8.1	90	87	0.0347	3.02	0	0.00	0.25	23.0	0.2	0.0	5.4	0.2	90	0.32	0.73	1.0	0.5	0.37	3.38	64.69	8.13	HGL Too High!
P42	DI31	MH22	1.00	51.34	51.34	15	2.0	1.6	7.5	55.8	0.0008	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	51.40	5.12	HGL Too High!
P43	MH22	DI32	1.00	51.29	51.29	15	2.0	1.6	80	45.1	0.0008	0.04	0	0.00	0.01	3.3	0.0	0.0	1.6	0.0	7.5	0.00	0.03	1.0	0.5	0.01	0.05	51.34	5.45	HGL Too High!
P44	DI32	EX	1.00	50.41	50.41	15	7.0	5.7	90	59.3	0.0101	0.60	0	0.00	0.13	3.2	6.6	0.0	2.3	0.0	94	0.06	0.21	1.3	1.0	0.28	0.88	51.29	5.23	HGL Too High!
P46	DI34	DI33	1.00	51.40	51.40	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	51.40	5.47	HGL Too High!
P45	DI33	DI32	1.00	51.29	51.29	15	2.9	2.3	94	48.5	0.0017	0.08	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.11	51.40	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	29.61	29.61	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	29.61	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	61.70	61.70	12	2.1	2.7	0	47	0.0030	0.14	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.17	61.87	3.63	HGL Too High!
P48	DI40	DI41	0.80	61.70	61.70	12	0.6	0.7	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	61.72	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	61.31	61.31	12	3.1	3.9	95	41	0.0064	0.26	0	0.00	0.06	0.4	5.7	0.0	2.7	0.0	0	0.00	0.10	1.3	1.0	0.13	0.39	61.70	4.62	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

Project:	South Market Street Infrastructure Improvements	Prepared by: RKK	Design Date: 2/23/2023	Sheet No.:	of		
County:	New Castle	Checked by: RKK	Model Date: 3/23/2023	Cm. No.:	20077		
Segment:	Market Street Existing Conditions 24" Outfall	Storm Frequency: 50	-year (50-year for sumps)				

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
MARKET ST RIVER WEST OUTFALL																										
SOUTH SECTION TO 24"																										
P4	DI15	MH1	3244	1216	4460	0.10	0.89	0.09	0.09	6.0	0.00	7.29	0.7	15	27.3	0.012	0.000090	0.005	4.1	5.0	2.9	0.16	6.16	4.49	4.35	Q ok
P5	MH1	MH2	1	0	1	0.00	1.00	0.00	0.19	6.0	6.16	7.23	1.3	18	82.7	0.012	0.000140	0.005	4.5	8.0	3.2	0.43	6.59	4.25	3.84	Q ok
P7	MH2	MH3	1	0	1	0.00	1.00	0.00	0.28	6.0	6.59	7.10	2.0	18	73.8	0.012	0.000309	0.005	4.6	8.1	3.7	0.33	6.92	3.81	3.44	Q ok
P10	MH3	MH4	1	0	1	0.00	1.00	0.00	0.52	6.0	6.92	7.01	3.6	18	53.7	0.012	0.001015	0.005	4.6	8.1	4.4	0.20	7.12	3.34	3.07	Q ok
P13	MH4	MH5	1	0	1	0.00	1.00	0.00	0.90	6.0	7.12	6.95	6.2	18	59.3	0.012	0.002989	0.005	4.3	7.7	4.9	0.20	7.33	2.97	2.70	Q ok
P15	MH5	MH20	1	0	1	0.00	1.00	0.00	1.36	6.0	7.33	6.89	9.3	24	104.1	0.012	0.001453	0.020	11.1	34.8	9.1	0.19	7.52	2.60	0.50	Q ok
P6	DI16	MH2	3400	1275	4675	0.11	0.89	0.10	0.10	6.0	0.00	7.29	0.7	15	29.3	0.012	0.000099	0.005	4.1	5.0	2.9	0.17	6.17	4.06	3.91	Q ok
P9	DI3	MH3	4110	3259	7369	0.17	0.73	0.12	0.12	6.0	0.00	7.29	0.9	15	18.3	0.012	0.000166	0.005	4.0	4.9	3.0	0.10	6.10	3.68	3.59	Q ok
P8	DI17	MH3	3878	2100	5978	0.14	0.82	0.11	0.11	6.0	0.00	7.29	0.8	15	31.3	0.012	0.000136	0.005	4.2	5.2	2.9	0.18	6.18	3.71	3.54	Q ok
P12	DI4	MH4	7109	2561	9670	0.22	0.90	0.20	0.20	6.0	0.00	6.73	1.3	15	20.1	0.012	0.000365	0.005	4.0	4.9	3.3	0.10	6.10	3.48	3.38	Q ok
P11	DI18	MH4	6435	2210	8645	0.20	0.90	0.18	0.18	6.0	0.00	6.70	1.2	15	28.4	0.012	0.000295	0.005	4.1	5.1	3.4	0.14	6.14	3.48	3.33	Q ok
P14	DI5	MH5	4974	2549	7523	0.17	0.83	0.14	0.14	6.0	0.00	7.29	1.0	15	22.6	0.012	0.000221	0.005	4.0	4.9	3.0	0.12	6.12	3.68	3.57	Q ok
P18	DI6	MH6	6937	1863	8800	0.20	0.94	0.19	0.19	6.0	0.00	7.29	1.4	15	38.0	0.012	0.000395	0.005	4.0	4.9	3.4	0.18	6.18	4.57	4.38	Q ok
P16	MH6	MH5	1	0	1	0.00	1.00	0.00	0.32	6.0	6.18	7.23	2.3	18	40.0	0.012	0.000408	0.011	6.8	12.1	5.1	0.13	6.32	3.77	3.32	Q ok
P17	DI19	MH6	4542	1703	6245	0.14	0.89	0.13	0.13	6.0	0.00	7.29	0.9	15	33.0	0.012	0.000176	0.005	4.0	4.9	3.0	0.18	6.18	4.19	4.02	Q ok
NORTH SECTION TO 24"																										
P32	DI23	MH12	5495	1914	7409	0.17	0.90	0.15	0.15	6.0	0.00	7.29	1.1	15	33.31	0.012	0.0003	0.005	4.1	5.0	3.1	0.18	6.18	3.98	3.81	Q ok
P31	DI9	MH12	4483	551	5034	0.12	1.00	0.12	0.12	6.0	0.00	7.29	0.8	15	18.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.11	6.11	3.86	3.77	Q ok
P30	MH12	MH11	1	0	1	0.00	1.00	0.00	0.27	6.0	6.18	7.23	1.9	18	50.1	0.012	0.0003	0.005	4.5	8.0	3.7	0.22	6.41	3.67	3.42	Q ok
P27	MH11	MH10	1	0	1	0.00	1.00	0.00	0.55	6.0	6.41	7.17	4.0	18	73.2	0.012	0.0012	0.005	4.6	8.1	4.5	0.27	6.67	3.39	3.02	Q ok
P25	MH10	MH9	1	0	1	0.00	1.00	0.00	0.63	6.0	6.67	7.07	4.5	24	69.68	0.012	0.0003	0.006	6.3	19.7	5.1	0.23	6.90	2.92	2.47	Q ok
P22	MH9	MH8	1	0	1	0.00	1.00	0.00	0.81	6.0	6.90	7.01	5.6	24	108.3	0.012	0.0005	0.005	5.5	17.3	5.0	0.36	7.26	2.47	1.93	Q ok
P20	MH8	MH21	1	0	1	0.00	1.00	0.00	1.03	6.0	7.26	6.89	7.1	24	57.3	0.012	0.0008	0.021	11.4	35.8	8.5	0.11	7.38	1.65	0.43	Q ok
P21	MH21	EXMH1	1	0	1	0.00	1.00	0.00	1.03	6.0	7.38	6.86	7.1	24	11.3	0.012	0.0008	0.005	5.7	17.9	5.2	0.04	7.41	0.33	0.27	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 50 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P47	DI35	EXMH1	29988	0	29988	0.69	1.00	0.69	0.69	6.0	0.00	7.29	5.0	18	7.75	0.012	0.0019	0.008	5.8	10.3	5.7	0.02	6.02	-0.50	-0.56	Q ok
P-80	DI-80	MH-08	9967	0	9967	0.23	1.00	0.23	0.23	6.0	0.00	7.29	1.7	15	49	0.012	0.0006	0.009	5.5	6.8	4.5	0.18	6.18	4.53	4.07	Q ok
P52	TDI50	DI22	8815	0	8815	0.20	1.00	0.20	0.20	6.0	0.00	7.29	1.5	8	17	0.012	0.0127	0.010	3.8	1.3	3.1	0.09	6.09	3.92	3.75	Undersized!
P51	STUB	DI22	21322	0	21322	0.49	1.00	0.49	0.49	6.0	0.00	7.29	3.6	15	10.02	0.012	0.0026	0.005	4.0	4.9	4.4	0.04	6.04	3.79	3.74	Q ok
P28	DI22	MH11	5555	1955	7510	0.17	0.90	0.16	0.16	6.0	0.00	7.29	1.1	15	30.3	0.012	0.0003	0.005	4.0	4.9	3.3	0.15	6.15	3.64	3.49	Q ok
P29	DI8	MH11	5120	570	5690	0.13	1.00	0.13	0.13	6.0	0.00	7.29	1.0	15	18.3	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.64	3.55	Q ok
P26	DI21	MH10	2755	930	3685	0.08	0.91	0.08	0.08	6.0	0.00	7.29	0.6	15	18.3	0.012	0.0001	0.005	4.0	4.9	2.4	0.13	6.13	4.02	3.93	Q ok
P23	DI20	MH9	3213	1102	4315	0.10	0.90	0.09	0.09	6.0	0.00	7.29	0.7	15	29.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.17	6.17	4.53	4.38	Q ok
P24	DI7	MH9	3164	527	3691	0.08	1.00	0.08	0.08	6.0	0.00	7.29	0.6	15	28.02	0.012	0.0001	0.005	4.0	4.9	2.4	0.19	6.19	4.38	4.24	Q ok
SOUTH SECTION LOW TRUNK TO 24" OUTFALL																										
CRB-P72	CRB-DI72	CRB-MH-74	6086	0	6086	0.14	1.00	0.14	0.14	6.0	0.00	7.29	1.0	15	16	0.012	0.0002	0.019	7.8	9.6	4.7	0.06	6.06	2.60	2.30	Q ok
CRB-P73	CRB-DI73	CRB-MH-74	7042	0	7042	0.16	1.00	0.16	0.16	6.0	0.00	7.29	1.2	15	34	0.012	0.0003	0.005	4.0	4.9	3.3	0.17	6.17	1.92	1.75	Q ok
CRB-P74	CRB-MH-74	CRB-MH-67	1	0	1	0.00	1.00	0.00	0.30	6.0	6.17	7.23	2.2	15	154	0.012	0.0010	0.005	4.1	5.1	4.0	0.64	6.81	1.65	0.84	Q ok
EXP2	CRB-MH-67	EXMH3	1	0	1	0.00	1.00	0.00	0.76	6.0	6.81	7.04	5.3	15	23	0.013	0.0068	***0.003***	***2.7***	3.3	2.2	0.17	6.99	-1.14	-1.20	Undersized!
EXP3	EXMH3	EXMH4	1	0	1	0.00	1.00	0.00	0.93	6.0	6.99	6.98	6.5	15	78	0.013	0.0101	***0.003***	***2.7***	3.3	2.2	0.59	7.58	-1.20	-1.40	Undersized!
EXP4	EXMH4	EXMH5	1	0	1	0.00	1.00	0.00	0.93	6.0	7.58	6.79	6.3	15	54	0.013	0.0095	***0.003***	***2.7***	3.3	2.2	0.41	7.99	-1.40	-1.54	Undersized!
EXP5	EXMH5	EXMH6	1	0	1	0.00	1.00	0.00	2.11	6.0	7.99	6.67	14.1	15	263	0.013	0.0473	***0.003***	***2.7***	3.3	2.2	2.00	9.99	-1.54	-2.22	Undersized!
EXP6	EXMH6	EXMH7	1	0	1	0.00	1.00	0.00	3.15	6.0	9.99	6.05	19.1	15	96	0.013	0.0873	***0.003***	***2.7***	3.3	2.2	0.73	10.71	-2.22	-2.47	Undersized!
EXP7	EXMH7	EXMH8	1	0	1	0.00	1.00	0.00	3.15	6.0	10.71	5.92	18.7	15	175	0.013	0.0835	***0.003***	***2.7***	3.3	2.2	1.33	12.04	-2.47	-2.92	Undersized!
EXP8	EXMH8	EXMH9	1	0	1	0.00	1.00	0.00	3.16	6.0	12.04	5.67	17.9	24	41	0.013	0.0063	0.009	6.8	21.4	7.7	0.09	12.13	-2.92	-3.29	Q ok
EXP9	EXMH9	EXMH10	1	0	1	0.00	1.00	0.00	4.88	6.0	12.13	5.65	27.6	24	124	0.013	0.0148	0.009	6.8	21.4	5.6	0.37	12.50	-3.29	-4.40	Undersized!
EXP10	EXMH10	EXMH11	1	0	1	0.00	1.00	0.00	6.23	6.0	12.50	5.58	34.8	24	8	0.013	0.0236	***0.001***	***2.7***	8.5	2.2	0.06	12.56	-4.40	-4.41	Undersized!
EXP11	EXMH11	EXMH12	1	0	1	0.00	1.00	0.00	6.23	6.0	12.56	5.56	34.6	24	252	0.013	0.0234	***0.001***	***2.7***	8.5	2.2	1.90	14.46	-4.41	-4.76	Undersized!
EXP12	EXMH12	EXMH13	1	0	1	0.00	1.00	0.00	6.23	6.0	14.46	5.20	32.4	24	221	0.013	0.0205	***0.001***	***2.7***	8.5	2.2	1.67	16.13	-4.76	-5.07	Undersized!
EXP13	**EXMH13**	**OUTFALL**	**1**	**0**	**1**	**0.00**	1.00	**0.00**	**6.23**	**6.0**	**16.13**	5.01	31.2	**24**	**98**	**0.013**	**0.0190**	***0.001***	***2.7***	**8.5**	**2.2**	**0.74**	**16.87**	**-5.07**	**-5.21**	**Undersized!**
ROOF	COLLINS	MSS DI-13	8875	0	8875	0.20	1.00	0.20	0.20	6.0	0.00	7.29	1.5	4	16	0.012	0.5190	0.019	3.2	0.3	2.7	0.10	6.10	2.60	2.30	Undersized!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 50 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
CRB-P75	TD-03	MSS DI-13	2341	0	2341	0.05	1.00	0.05	0.05	6.0	0.00	7.29	**0.39**	8	33	0.011	0.000753	0.0348	7.6	**2.7**	5.3	0.10	6.10	4.57	3.42	Q ok
P3	DI14	DI13	3876	441	4317	0.10	1.00	0.10	0.10	6.0	0.00	7.29	0.7	15	69.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.41	6.41	4.03	3.68	Q ok
EXP1	DI13	MH67	3876	441	4317	0.10	1.00	0.10	0.46	6.0	6.41	7.17	3.3	15	15	0.013	0.0026	***0.003***	***2.7***	3.3	3.1	0.08	6.49	-1.10	-1.14	Q ok
P2	DI2	DI1	3846	1139	4985	0.11	0.93	0.11	0.11	6.0	0.00	7.29	0.8	15	69.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.41	6.41	4.03	3.68	Q ok
P1	DI1	EXMH	2301	1082	3383	0.08	0.84	0.07	0.17	6.0	6.41	7.17	1.2	15	3.34	0.012	0.0003	0.005	4.0	4.9	3.3	0.02	6.43	3.39	3.37	Q ok
CRB-P84	TD-04	EXMH	1667	0	1667	0.04	1.00	0.04	0.04	6.0	0.00	7.29	**0.28**	8	46	0.011	0.000382	0.0383	8.0	**2.8**	4.8	0.16	6.16	6.26	4.50	Q ok
EXP15	EXDI	EXMH	24757	6130	30887	0.71	0.96	0.68	0.68	6.0	0.00	7.29	**4.94**	12	87	0.012	0.016413	0.0049	3.5	**2.7**	2.8	0.51	6.51	2.00	1.57	Undersized!
EXP16	EXMH	EXMH5	1	0	1	0.00	1.00	0.00	0.72	6.0	6.51	7.14	**5.11**	10	87	0.012	0.046402	0.0049	3.1	**1.7**	2.5	0.58	7.09	2.00	1.57	Undersized!
P42	DI31	MH22	12796.5	0	12797	0.29	1.00	0.29	0.29	6.0	0.00	7.29	2.1	15	55.8	0.012	0.0009	0.005	4.0	5.0	3.9	0.24	6.24	2.00	1.72	Q ok
P43	MH22	DI32	1	0	1	0.00	1.00	0.00	0.29	6.0	6.24	7.23	2.1	15	45.1	0.012	0.0009	0.005	4.1	5.0	3.7	0.20	6.44	1.62	1.39	Q ok
P44	DI32	EX	14459.5	0	14460	0.33	1.00	0.33	1.05	6.0	6.44	7.17	7.5	15	59.3	0.012	0.0115	0.030	9.9	12.1	10.4	0.10	6.53	1.29	0.70	Q ok
P46	DI34	DI33	2420	0	2420	0.06	1.00	0.06	0.06	6.0	0.00	7.29	0.4	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.4	0.26	6.26	2.00	1.82	Q ok
P45	DI33	DI32	15975	0	15975	0.37	1.00	0.37	0.42	6.0	6.26	7.20	3.0	15	48.5	0.012	0.0019	0.007	4.7	5.8	4.8	0.17	6.43	1.72	1.39	Q ok
EXP17	EXMH	EXMH8	1	0	1	0.00	1.00	0.00	0.00	6.0	0.00	7.29	0.0	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.0	0.32	6.32	2.00	1.82	Q ok
EX-P LOT	EXDI LOT	DI-MSS-41	13430	0	13430	0.31	1.00	0.31	0.31	6.0	0.00	7.29	**2.25**	12	47	0.012	0.003391	0.0074	4.2	**3.3**	4.5	0.17	6.17	2.50	2.15	Q ok
P48	DI40	DI41	3590	0	3590	0.08	1.00	0.08	0.08	6.0	0.00	7.29	0.6	12	82.1	0.012	0.0002	0.005	3.5	2.7	2.6	0.53	6.53	2.56	2.15	Q ok
P-MSS-48A	DI-MSS-41	EX-MH LOW	3072	0	3072	0.07	1.00	0.07	0.46	6.0	6.53	7.14	**3.29**	12	41	0.012	0.007270	0.0051	3.5	**2.8**	2.9	0.24	6.76	2.05	1.84	Undersized!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	19.47	19.47	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.48	7.41	
P5	MH1	MH2	1.20	19.46	19.46	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	19.47	7.93	HGL Too High!
P7	MH2	MH3	1.20	19.43	19.43	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	19.46	7.65	HGL Too High!
P10	MH3	MH4	1.20	19.36	19.36	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	19.43	7.28	HGL Too High!
P13	MH4	MH5	1.20	19.15	19.15	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	19.36	7.09	HGL Too High!
P15	MH5	MH20	1.60	18.88	18.88	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	19.15	7.40	HGL Too High!
P6	DI16	MH2	1.00	19.46	19.46	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.46	7.33	HGL Too High!
P9	DI3	MH3	1.00	19.43	19.43	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.44	6.62	HGL Too High!
P8	DI17	MH3	1.00	19.43	19.43	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.44	6.96	HGL Too High!
P12	DI4	MH4	1.00	19.36	19.36	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.38	6.48	HGL Too High!
P11	DI18	MH4	1.00	19.36	19.36	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.38	6.56	HGL Too High!
P14	DI5	MH5	1.00	19.15	19.15	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.16	6.61	HGL Too High!
P18	DI6	MH6	1.00	19.17	19.17	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	19.19	7.13	HGL Too High!
P16	MH6	MH5	1.20	19.15	19.15	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	19.17	7.55	HGL Too High!
P17	DI19	MH6	1.00	19.17	19.17	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.18	7.08	HGL Too High!
P32	DI23	MH12	1.00	21.49	21.49	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.50	4.24	HGL Too High!
P31	DI9	MH12	1.00	21.49	21.49	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.49	7.13	HGL Too High!
P30	MH12	MH11	1.60	21.47	21.47	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	21.49	7.48	HGL Too High!
P27	MH11	MH10	1.60	21.38	21.38	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	21.47	7.21	HGL Too High!
P25	MH10	MH9	1.60	21.34	21.34	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	21.38	7.54	HGL Too High!
P22	MH9	MH8	1.60	21.27	21.27	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	21.34	7.85	HGL Too High!
P20	MH8	MH21	1.60	21.19	21.19	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	21.27	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	21.13	21.13	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	21.19	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	21.13	21.13	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	21.18	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	21.27	21.27	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	21.31	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	21.53	21.53	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	21.81	4.78	HGL Too High!
P51	STUB	DI22	1.00	21.53	21.53	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	21.57	7.16	HGL Too High!
P28	DI22	MH11	1.00	21.47	21.47	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	21.53	6.74	HGL Too High!
P29	DI8	MH11	1.00	21.47	21.47	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.47	6.92	HGL Too High!
P26	DI21	MH10	1.00	21.38	21.38	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.38	7.23	HGL Too High!
P23	DI20	MH9	1.00	21.34	21.34	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	21.35	7.38	HGL Too High!
P24	DI7	MH9	1.00	21.34	21.34	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.35	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	63.44	63.44	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	63.45	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	63.44	63.44	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	63.46	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	63.28	63.28	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	63.44	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	63.07	63.07	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	63.28	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	62.07	62.07	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	63.07	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	61.43	61.43	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	62.07	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	48.01	48.01	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	61.43	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	38.81	38.81	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	48.01	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	23.09	23.09	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	38.81	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	21.13	21.13	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	23.09	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	18.88	18.88	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	21.13	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	17.96	17.96	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	18.88	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	10.86	10.86	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	17.96	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	5.79	5.79	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	10.86	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.20**	**3.20**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**5.79**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	65.40	65.40	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	74.27	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	65.40	65.40	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	65.43	6.45	HGL Too High!
P3	DI14	DI13	1.00	65.40	65.40	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	65.41	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	63.28	63.28	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	65.40	6.58	HGL Too High!
P2	DI2	DI1	1.00	63.08	63.08	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	63.09	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	63.07	63.07	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	63.08	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	65.96	65.96	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	65.98	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	65.96	65.96	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	67.54	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	61.43	61.43	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	65.96	8.13	HGL Too High!
P42	DI31	MH22	1.00	49.07	49.07	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	49.14	5.12	HGL Too High!
P43	MH22	DI32	1.00	49.02	49.02	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	49.07	5.45	HGL Too High!
P44	DI32	EX	1.00	48.01	48.01	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	49.02	5.23	HGL Too High!
P46	DI34	DI33	1.00	49.14	49.14	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	49.14	5.47	HGL Too High!
P45	DI33	DI32	1.00	49.02	49.02	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	49.14	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	23.09	23.09	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	23.09	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	61.88	61.88	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	62.07	3.63	HGL Too High!
P48	DI40	DI41	0.80	61.88	61.88	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	61.90	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	61.43	61.43	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	61.88	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	19.67	19.67	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.68	7.41	
P5	MH1	MH2	1.20	19.66	19.66	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	19.67	7.93	HGL Too High!
P7	MH2	MH3	1.20	19.63	19.63	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	19.66	7.65	HGL Too High!
P10	MH3	MH4	1.20	19.56	19.56	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	19.63	7.28	HGL Too High!
P13	MH4	MH5	1.20	19.35	19.35	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	19.56	7.09	HGL Too High!
P15	MH5	MH20	1.60	19.08	19.08	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	19.35	7.40	HGL Too High!
P6	DI16	MH2	1.00	19.66	19.66	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	19.66	7.33	HGL Too High!
P9	DI3	MH3	1.00	19.63	19.63	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.64	6.62	HGL Too High!
P8	DI17	MH3	1.00	19.63	19.63	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.64	6.96	HGL Too High!
P12	DI4	MH4	1.00	19.56	19.56	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.58	6.48	HGL Too High!
P11	DI18	MH4	1.00	19.56	19.56	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.58	6.56	HGL Too High!
P14	DI5	MH5	1.00	19.35	19.35	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.36	6.61	HGL Too High!
P18	DI6	MH6	1.00	19.37	19.37	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	19.39	7.13	HGL Too High!
P16	MH6	MH5	1.20	19.35	19.35	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	19.37	7.55	HGL Too High!
P17	DI19	MH6	1.00	19.37	19.37	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	19.38	7.08	HGL Too High!
P32	DI23	MH12	1.00	21.69	21.69	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.70	4.24	HGL Too High!
P31	DI9	MH12	1.00	21.69	21.69	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.69	7.13	HGL Too High!
P30	MH12	MH11	1.60	21.67	21.67	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	21.69	7.48	HGL Too High!
P27	MH11	MH10	1.60	21.58	21.58	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	21.67	7.21	HGL Too High!
P25	MH10	MH9	1.60	21.54	21.54	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	21.58	7.54	HGL Too High!
P22	MH9	MH8	1.60	21.47	21.47	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	21.54	7.85	HGL Too High!
P20	MH8	MH21	1.60	21.39	21.39	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	21.47	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	21.33	21.33	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	21.39	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	21.33	21.33	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	21.38	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	21.47	21.47	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	21.51	7.34	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	21.73	21.73	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	22.01	4.78	HGL Too High!
P51	STUB	DI22	1.00	21.73	21.73	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	21.77	7.16	HGL Too High!
P28	DI22	MH11	1.00	21.67	21.67	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	21.73	6.74	HGL Too High!
P29	DI8	MH11	1.00	21.67	21.67	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.67	6.92	HGL Too High!
P26	DI21	MH10	1.00	21.58	21.58	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.58	7.23	HGL Too High!
P23	DI20	MH9	1.00	21.54	21.54	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	21.55	7.38	HGL Too High!
P24	DI7	MH9	1.00	21.54	21.54	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	21.55	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	63.64	63.64	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	63.65	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	63.64	63.64	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	63.66	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	63.48	63.48	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	63.64	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	63.27	63.27	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	63.48	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	62.27	62.27	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	63.27	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	61.63	61.63	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	62.27	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	48.21	48.21	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	61.63	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	39.01	39.01	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	48.21	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	23.29	23.29	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	39.01	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	21.33	21.33	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	23.29	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	19.08	19.08	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	21.33	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	18.16	18.16	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	19.08	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	11.06	11.06	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	18.16	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	5.99	5.99	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	11.06	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.40**	**3.40**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**5.99**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	65.60	65.60	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	74.47	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	65.60	65.60	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	65.63	6.45	HGL Too High!
P3	DI14	DI13	1.00	65.60	65.60	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	65.61	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	63.48	63.48	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	65.60	6.58	HGL Too High!
P2	DI2	DI1	1.00	63.28	63.28	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	63.29	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	63.27	63.27	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	63.28	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	66.16	66.16	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	66.18	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	66.16	66.16	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	67.74	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	61.63	61.63	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	66.16	8.13	HGL Too High!
P42	DI31	MH22	1.00	49.27	49.27	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	49.34	5.12	HGL Too High!
P43	MH22	DI32	1.00	49.22	49.22	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	49.27	5.45	HGL Too High!
P44	DI32	EX	1.00	48.21	48.21	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	49.22	5.23	HGL Too High!
P46	DI34	DI33	1.00	49.34	49.34	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	49.34	5.47	HGL Too High!
P45	DI33	DI32	1.00	49.22	49.22	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	49.34	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	23.29	23.29	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	23.29	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	62.08	62.08	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	62.27	3.63	HGL Too High!
P48	DI40	DI41	0.80	62.08	62.08	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	62.10	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	61.63	61.63	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	62.08	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	23.17	23.17	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.18	7.41	
P5	MH1	MH2	1.20	23.16	23.16	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	23.17	7.93	HGL Too High!
P7	MH2	MH3	1.20	23.13	23.13	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	23.16	7.65	HGL Too High!
P10	MH3	MH4	1.20	23.06	23.06	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	23.13	7.28	HGL Too High!
P13	MH4	MH5	1.20	22.85	22.85	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	23.06	7.09	HGL Too High!
P15	MH5	MH20	1.60	22.58	22.58	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	22.85	7.40	HGL Too High!
P6	DI16	MH2	1.00	23.16	23.16	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.16	7.33	HGL Too High!
P9	DI3	MH3	1.00	23.13	23.13	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.14	6.62	HGL Too High!
P8	DI17	MH3	1.00	23.13	23.13	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.14	6.96	HGL Too High!
P12	DI4	MH4	1.00	23.06	23.06	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.08	6.48	HGL Too High!
P11	DI18	MH4	1.00	23.06	23.06	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.08	6.56	HGL Too High!
P14	DI5	MH5	1.00	22.85	22.85	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.86	6.61	HGL Too High!
P18	DI6	MH6	1.00	22.87	22.87	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	22.89	7.13	HGL Too High!
P16	MH6	MH5	1.20	22.85	22.85	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	22.87	7.55	HGL Too High!
P17	DI19	MH6	1.00	22.87	22.87	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.88	7.08	HGL Too High!
P32	DI23	MH12	1.00	25.19	25.19	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.20	4.24	HGL Too High!
P31	DI9	MH12	1.00	25.19	25.19	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.19	7.13	HGL Too High!
P30	MH12	MH11	1.60	25.17	25.17	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	25.19	7.48	HGL Too High!
P27	MH11	MH10	1.60	25.08	25.08	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	25.17	7.21	HGL Too High!
P25	MH10	MH9	1.60	25.04	25.04	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	25.08	7.54	HGL Too High!
P22	MH9	MH8	1.60	24.97	24.97	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	25.04	7.85	HGL Too High!
P20	MH8	MH21	1.60	24.89	24.89	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	24.97	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	24.83	24.83	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	24.89	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	24.83	24.83	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	24.88	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	24.97	24.97	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	25.01	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	25.23	25.23	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	25.51	4.78	HGL Too High!
P51	STUB	DI22	1.00	25.23	25.23	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	25.27	7.16	HGL Too High!
P28	DI22	MH11	1.00	25.17	25.17	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	25.23	6.74	HGL Too High!
P29	DI8	MH11	1.00	25.17	25.17	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.17	6.92	HGL Too High!
P26	DI21	MH10	1.00	25.08	25.08	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.08	7.23	HGL Too High!
P23	DI20	MH9	1.00	25.04	25.04	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	25.05	7.38	HGL Too High!
P24	DI7	MH9	1.00	25.04	25.04	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.05	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	67.14	67.14	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	67.15	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	67.14	67.14	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	67.16	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	66.98	66.98	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	67.14	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	66.77	66.77	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	66.98	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	65.77	65.77	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	66.77	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	65.13	65.13	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	65.77	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	51.71	51.71	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	65.13	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	42.51	42.51	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	51.71	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	26.79	26.79	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	42.51	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	24.83	24.83	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	26.79	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	22.58	22.58	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	24.83	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	21.66	21.66	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	22.58	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	14.56	14.56	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	21.66	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.49	9.49	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	14.56	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**6.90**	**6.90**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**9.49**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	69.10	69.10	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	77.97	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	69.10	69.10	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	69.13	6.45	HGL Too High!
P3	DI14	DI13	1.00	69.10	69.10	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	69.11	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	66.98	66.98	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	69.10	6.58	HGL Too High!
P2	DI2	DI1	1.00	66.78	66.78	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	66.79	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	66.77	66.77	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	66.78	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	69.66	69.66	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	69.68	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	69.66	69.66	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	71.24	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	65.13	65.13	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	69.66	8.13	HGL Too High!
P42	DI31	MH22	1.00	52.77	52.77	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	52.84	5.12	HGL Too High!
P43	MH22	DI32	1.00	52.72	52.72	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	52.77	5.45	HGL Too High!
P44	DI32	EX	1.00	51.71	51.71	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	52.72	5.23	HGL Too High!
P46	DI34	DI33	1.00	52.84	52.84	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	52.84	5.47	HGL Too High!
P45	DI33	DI32	1.00	52.72	52.72	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	52.84	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	26.79	26.79	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	26.79	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	65.58	65.58	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	65.77	3.63	HGL Too High!
P48	DI40	DI41	0.80	65.58	65.58	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	65.60	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	65.13	65.13	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	65.58	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	23.67	23.67	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.68	7.41	
P5	MH1	MH2	1.20	23.66	23.66	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	23.67	7.93	HGL Too High!
P7	MH2	MH3	1.20	23.63	23.63	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	23.66	7.65	HGL Too High!
P10	MH3	MH4	1.20	23.56	23.56	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	23.63	7.28	HGL Too High!
P13	MH4	MH5	1.20	23.35	23.35	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	23.56	7.09	HGL Too High!
P15	MH5	MH20	1.60	23.08	23.08	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	23.35	7.40	HGL Too High!
P6	DI16	MH2	1.00	23.66	23.66	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.66	7.33	HGL Too High!
P9	DI3	MH3	1.00	23.63	23.63	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.64	6.62	HGL Too High!
P8	DI17	MH3	1.00	23.63	23.63	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.64	6.96	HGL Too High!
P12	DI4	MH4	1.00	23.56	23.56	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.58	6.48	HGL Too High!
P11	DI18	MH4	1.00	23.56	23.56	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.58	6.56	HGL Too High!
P14	DI5	MH5	1.00	23.35	23.35	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.36	6.61	HGL Too High!
P18	DI6	MH6	1.00	23.37	23.37	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	23.39	7.13	HGL Too High!
P16	MH6	MH5	1.20	23.35	23.35	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	23.37	7.55	HGL Too High!
P17	DI19	MH6	1.00	23.37	23.37	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.38	7.08	HGL Too High!
P32	DI23	MH12	1.00	25.69	25.69	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.70	4.24	HGL Too High!
P31	DI9	MH12	1.00	25.69	25.69	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.69	7.13	HGL Too High!
P30	MH12	MH11	1.60	25.67	25.67	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	25.69	7.48	HGL Too High!
P27	MH11	MH10	1.60	25.58	25.58	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	25.67	7.21	HGL Too High!
P25	MH10	MH9	1.60	25.54	25.54	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	25.58	7.54	HGL Too High!
P22	MH9	MH8	1.60	25.47	25.47	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	25.54	7.85	HGL Too High!
P20	MH8	MH21	1.60	25.39	25.39	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	25.47	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	25.33	25.33	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	25.39	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	25.33	25.33	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	25.38	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	25.47	25.47	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	25.51	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	25.73	25.73	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	26.01	4.78	HGL Too High!
P51	STUB	DI22	1.00	25.73	25.73	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	25.77	7.16	HGL Too High!
P28	DI22	MH11	1.00	25.67	25.67	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	25.73	6.74	HGL Too High!
P29	DI8	MH11	1.00	25.67	25.67	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.67	6.92	HGL Too High!
P26	DI21	MH10	1.00	25.58	25.58	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.58	7.23	HGL Too High!
P23	DI20	MH9	1.00	25.54	25.54	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	25.55	7.38	HGL Too High!
P24	DI7	MH9	1.00	25.54	25.54	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.55	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	67.64	67.64	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	67.65	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	67.64	67.64	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	67.66	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	67.48	67.48	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	67.64	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	67.27	67.27	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	67.48	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	66.27	66.27	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	67.27	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	65.63	65.63	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	66.27	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	52.21	52.21	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	65.63	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	43.01	43.01	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	52.21	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	27.29	27.29	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	43.01	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	25.33	25.33	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	27.29	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	23.08	23.08	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	25.33	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	22.16	22.16	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	23.08	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.06	15.06	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	22.16	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.99	9.99	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	15.06	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.40**	**7.40**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**9.99**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	69.60	69.60	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	78.47	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	69.60	69.60	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	69.63	6.45	HGL Too High!
P3	DI14	DI13	1.00	69.60	69.60	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	69.61	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	67.48	67.48	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	69.60	6.58	HGL Too High!
P2	DI2	DI1	1.00	67.28	67.28	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	67.29	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	67.27	67.27	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	67.28	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	70.16	70.16	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	70.18	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	70.16	70.16	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	71.74	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	65.63	65.63	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	70.16	8.13	HGL Too High!
P42	DI31	MH22	1.00	53.27	53.27	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	53.34	5.12	HGL Too High!
P43	MH22	DI32	1.00	53.22	53.22	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	53.27	5.45	HGL Too High!
P44	DI32	EX	1.00	52.21	52.21	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	53.22	5.23	HGL Too High!
P46	DI34	DI33	1.00	53.34	53.34	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	53.34	5.47	HGL Too High!
P45	DI33	DI32	1.00	53.22	53.22	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	53.34	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	27.29	27.29	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	27.29	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	66.08	66.08	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	66.27	3.63	HGL Too High!
P48	DI40	DI41	0.80	66.08	66.08	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	66.10	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	65.63	65.63	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	66.08	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	24.07	24.07	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.08	7.41	
P5	MH1	MH2	1.20	24.06	24.06	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	24.07	7.93	HGL Too High!
P7	MH2	MH3	1.20	24.03	24.03	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	24.06	7.65	HGL Too High!
P10	MH3	MH4	1.20	23.96	23.96	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	24.03	7.28	HGL Too High!
P13	MH4	MH5	1.20	23.75	23.75	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	23.96	7.09	HGL Too High!
P15	MH5	MH20	1.60	23.48	23.48	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	23.75	7.40	HGL Too High!
P6	DI16	MH2	1.00	24.06	24.06	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.06	7.33	HGL Too High!
P9	DI3	MH3	1.00	24.03	24.03	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.04	6.62	HGL Too High!
P8	DI17	MH3	1.00	24.03	24.03	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.04	6.96	HGL Too High!
P12	DI4	MH4	1.00	23.96	23.96	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.98	6.48	HGL Too High!
P11	DI18	MH4	1.00	23.96	23.96	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.98	6.56	HGL Too High!
P14	DI5	MH5	1.00	23.75	23.75	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.76	6.61	HGL Too High!
P18	DI6	MH6	1.00	23.77	23.77	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	23.79	7.13	HGL Too High!
P16	MH6	MH5	1.20	23.75	23.75	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	23.77	7.55	HGL Too High!
P17	DI19	MH6	1.00	23.77	23.77	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.78	7.08	HGL Too High!
P32	DI23	MH12	1.00	26.09	26.09	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.10	4.24	HGL Too High!
P31	DI9	MH12	1.00	26.09	26.09	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.09	7.13	HGL Too High!
P30	MH12	MH11	1.60	26.07	26.07	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	26.09	7.48	HGL Too High!
P27	MH11	MH10	1.60	25.98	25.98	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	26.07	7.21	HGL Too High!
P25	MH10	MH9	1.60	25.94	25.94	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	25.98	7.54	HGL Too High!
P22	MH9	MH8	1.60	25.87	25.87	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	25.94	7.85	HGL Too High!
P20	MH8	MH21	1.60	25.79	25.79	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	25.87	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	25.73	25.73	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	25.79	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	25.73	25.73	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	25.78	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	25.87	25.87	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	25.91	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	26.13	26.13	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	26.41	4.78	HGL Too High!
P51	STUB	DI22	1.00	26.13	26.13	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	26.17	7.16	HGL Too High!
P28	DI22	MH11	1.00	26.07	26.07	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	26.13	6.74	HGL Too High!
P29	DI8	MH11	1.00	26.07	26.07	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.07	6.92	HGL Too High!
P26	DI21	MH10	1.00	25.98	25.98	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.98	7.23	HGL Too High!
P23	DI20	MH9	1.00	25.94	25.94	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	25.95	7.38	HGL Too High!
P24	DI7	MH9	1.00	25.94	25.94	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.95	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	68.04	68.04	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	68.05	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	68.04	68.04	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	68.06	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	67.88	67.88	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	68.04	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	67.67	67.67	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	67.88	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	66.67	66.67	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	67.67	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	66.03	66.03	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	66.67	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	52.61	52.61	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	66.03	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	43.41	43.41	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	52.61	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	27.69	27.69	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	43.41	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	25.73	25.73	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	27.69	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	23.48	23.48	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	25.73	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	22.56	22.56	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	23.48	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.46	15.46	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	22.56	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.39	10.39	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	15.46	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.80**	**7.80**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**10.39**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	70.00	70.00	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	78.87	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	70.00	70.00	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	70.03	6.45	HGL Too High!
P3	DI14	DI13	1.00	70.00	70.00	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	70.01	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	67.88	67.88	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	70.00	6.58	HGL Too High!
P2	DI2	DI1	1.00	67.68	67.68	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	67.69	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	67.67	67.67	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	67.68	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	70.56	70.56	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	70.58	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	70.56	70.56	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	72.14	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	66.03	66.03	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	70.56	8.13	HGL Too High!
P42	DI31	MH22	1.00	53.67	53.67	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	53.74	5.12	HGL Too High!
P43	MH22	DI32	1.00	53.62	53.62	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	53.67	5.45	HGL Too High!
P44	DI32	EX	1.00	52.61	52.61	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	53.62	5.23	HGL Too High!
P46	DI34	DI33	1.00	53.74	53.74	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	53.74	5.47	HGL Too High!
P45	DI33	DI32	1.00	53.62	53.62	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	53.74	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	27.69	27.69	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	27.69	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	66.48	66.48	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	66.67	3.63	HGL Too High!
P48	DI40	DI41	0.80	66.48	66.48	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	66.50	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	66.03	66.03	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	66.48	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	24.57	24.57	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.58	7.41	
P5	MH1	MH2	1.20	24.56	24.56	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	24.57	7.93	HGL Too High!
P7	MH2	MH3	1.20	24.53	24.53	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	24.56	7.65	HGL Too High!
P10	MH3	MH4	1.20	24.46	24.46	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	24.53	7.28	HGL Too High!
P13	MH4	MH5	1.20	24.25	24.25	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	24.46	7.09	HGL Too High!
P15	MH5	MH20	1.60	23.98	23.98	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	24.25	7.40	HGL Too High!
P6	DI16	MH2	1.00	24.56	24.56	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.56	7.33	HGL Too High!
P9	DI3	MH3	1.00	24.53	24.53	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.54	6.62	HGL Too High!
P8	DI17	MH3	1.00	24.53	24.53	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.54	6.96	HGL Too High!
P12	DI4	MH4	1.00	24.46	24.46	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.48	6.48	HGL Too High!
P11	DI18	MH4	1.00	24.46	24.46	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.48	6.56	HGL Too High!
P14	DI5	MH5	1.00	24.25	24.25	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.26	6.61	HGL Too High!
P18	DI6	MH6	1.00	24.27	24.27	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	24.29	7.13	HGL Too High!
P16	MH6	MH5	1.20	24.25	24.25	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	24.27	7.55	HGL Too High!
P17	DI19	MH6	1.00	24.27	24.27	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.28	7.08	HGL Too High!
P32	DI23	MH12	1.00	26.59	26.59	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.60	4.24	HGL Too High!
P31	DI9	MH12	1.00	26.59	26.59	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.59	7.13	HGL Too High!
P30	MH12	MH11	1.60	26.57	26.57	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	26.59	7.48	HGL Too High!
P27	MH11	MH10	1.60	26.48	26.48	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	26.57	7.21	HGL Too High!
P25	MH10	MH9	1.60	26.44	26.44	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	26.48	7.54	HGL Too High!
P22	MH9	MH8	1.60	26.37	26.37	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	26.44	7.85	HGL Too High!
P20	MH8	MH21	1.60	26.29	26.29	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	26.37	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	26.23	26.23	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	26.29	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	26.23	26.23	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	26.28	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	26.37	26.37	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	26.41	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	26.63	26.63	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	26.91	4.78	HGL Too High!
P51	STUB	DI22	1.00	26.63	26.63	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	26.67	7.16	HGL Too High!
P28	DI22	MH11	1.00	26.57	26.57	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	26.63	6.74	HGL Too High!
P29	DI8	MH11	1.00	26.57	26.57	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.57	6.92	HGL Too High!
P26	DI21	MH10	1.00	26.48	26.48	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.48	7.23	HGL Too High!
P23	DI20	MH9	1.00	26.44	26.44	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	26.45	7.38	HGL Too High!
P24	DI7	MH9	1.00	26.44	26.44	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.45	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	68.54	68.54	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	68.55	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	68.54	68.54	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	68.56	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	68.38	68.38	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	68.54	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	68.17	68.17	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	68.38	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	67.17	67.17	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	68.17	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	66.53	66.53	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	67.17	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	53.11	53.11	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	66.53	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	43.91	43.91	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	53.11	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	28.19	28.19	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	43.91	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	26.23	26.23	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	28.19	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	23.98	23.98	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	26.23	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	23.06	23.06	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	23.98	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.96	15.96	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	23.06	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.89	10.89	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	15.96	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**8.30**	**8.30**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**10.89**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	70.50	70.50	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	79.37	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	70.50	70.50	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	70.53	6.45	HGL Too High!
P3	DI14	DI13	1.00	70.50	70.50	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	70.51	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	68.38	68.38	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	70.50	6.58	HGL Too High!
P2	DI2	DI1	1.00	68.18	68.18	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	68.19	6.84	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	68.17	68.17	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	68.18	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	71.06	71.06	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	71.08	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	71.06	71.06	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	72.64	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	66.53	66.53	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	71.06	8.13	HGL Too High!
P42	DI31	MH22	1.00	54.17	54.17	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	54.24	5.12	HGL Too High!
P43	MH22	DI32	1.00	54.12	54.12	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	54.17	5.45	HGL Too High!
P44	DI32	EX	1.00	53.11	53.11	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	54.12	5.23	HGL Too High!
P46	DI34	DI33	1.00	54.24	54.24	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	54.24	5.47	HGL Too High!
P45	DI33	DI32	1.00	54.12	54.12	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	54.24	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	28.19	28.19	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	28.19	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	66.98	66.98	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	67.17	3.63	HGL Too High!
P48	DI40	DI41	0.80	66.98	66.98	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	67.00	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	66.53	66.53	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	66.98	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	25.27	25.27	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.28	7.41	
P5	MH1	MH2	1.20	25.26	25.26	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	25.27	7.93	HGL Too High!
P7	MH2	MH3	1.20	25.23	25.23	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	25.26	7.65	HGL Too High!
P10	MH3	MH4	1.20	25.16	25.16	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	25.23	7.28	HGL Too High!
P13	MH4	MH5	1.20	24.95	24.95	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	25.16	7.09	HGL Too High!
P15	MH5	MH20	1.60	24.68	24.68	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	24.95	7.40	HGL Too High!
P6	DI16	MH2	1.00	25.26	25.26	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.26	7.33	HGL Too High!
P9	DI3	MH3	1.00	25.23	25.23	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.24	6.62	HGL Too High!
P8	DI17	MH3	1.00	25.23	25.23	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.24	6.96	HGL Too High!
P12	DI4	MH4	1.00	25.16	25.16	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.18	6.48	HGL Too High!
P11	DI18	MH4	1.00	25.16	25.16	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.18	6.56	HGL Too High!
P14	DI5	MH5	1.00	24.95	24.95	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.96	6.61	HGL Too High!
P18	DI6	MH6	1.00	24.97	24.97	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	24.99	7.13	HGL Too High!
P16	MH6	MH5	1.20	24.95	24.95	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	24.97	7.55	HGL Too High!
P17	DI19	MH6	1.00	24.97	24.97	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.98	7.08	HGL Too High!
P32	DI23	MH12	1.00	27.29	27.29	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.30	4.24	HGL Too High!
P31	DI9	MH12	1.00	27.29	27.29	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.29	7.13	HGL Too High!
P30	MH12	MH11	1.60	27.27	27.27	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	27.29	7.48	HGL Too High!
P27	MH11	MH10	1.60	27.18	27.18	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	27.27	7.21	HGL Too High!
P25	MH10	MH9	1.60	27.14	27.14	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	27.18	7.54	HGL Too High!
P22	MH9	MH8	1.60	27.07	27.07	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	27.14	7.85	HGL Too High!
P20	MH8	MH21	1.60	26.99	26.99	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	27.07	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	26.93	26.93	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	26.99	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	26.93	26.93	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	26.98	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	27.07	27.07	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	27.11	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	27.33	27.33	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	27.61	4.78	HGL Too High!
P51	STUB	DI22	1.00	27.33	27.33	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	27.37	7.16	HGL Too High!
P28	DI22	MH11	1.00	27.27	27.27	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	27.33	6.74	HGL Too High!
P29	DI8	MH11	1.00	27.27	27.27	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.27	6.92	HGL Too High!
P26	DI21	MH10	1.00	27.18	27.18	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.18	7.23	HGL Too High!
P23	DI20	MH9	1.00	27.14	27.14	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	27.15	7.38	HGL Too High!
P24	DI7	MH9	1.00	27.14	27.14	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.15	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	69.24	69.24	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	69.25	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	69.24	69.24	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	69.26	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	69.08	69.08	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	69.24	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	68.87	68.87	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	69.08	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	67.87	67.87	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	68.87	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	67.23	67.23	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	67.87	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	53.81	53.81	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	67.23	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	44.61	44.61	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	53.81	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	28.89	28.89	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	44.61	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	26.93	26.93	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	28.89	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	24.68	24.68	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	26.93	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	23.76	23.76	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	24.68	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	16.66	16.66	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	23.76	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.59	11.59	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	16.66	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.00**	**9.00**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**11.59**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	71.20	71.20	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	80.07	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	71.20	71.20	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	71.23	6.45	HGL Too High!
P3	DI14	DI13	1.00	71.20	71.20	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	71.21	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	69.08	69.08	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	71.20	6.58	HGL Too High!
P2	DI2	DI1	1.00	68.88	68.88	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	68.89	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	68.87	68.87	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	68.88	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	71.76	71.76	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	71.78	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	71.76	71.76	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	73.34	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	67.23	67.23	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	71.76	8.13	HGL Too High!
P42	DI31	MH22	1.00	54.87	54.87	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	54.94	5.12	HGL Too High!
P43	MH22	DI32	1.00	54.82	54.82	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	54.87	5.45	HGL Too High!
P44	DI32	EX	1.00	53.81	53.81	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	54.82	5.23	HGL Too High!
P46	DI34	DI33	1.00	54.94	54.94	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	54.94	5.47	HGL Too High!
P45	DI33	DI32	1.00	54.82	54.82	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	54.94	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	28.89	28.89	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	28.89	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	67.68	67.68	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	67.87	3.63	HGL Too High!
P48	DI40	DI41	0.80	67.68	67.68	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	67.70	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	67.23	67.23	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	67.68	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	25.77	25.77	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.78	7.41	
P5	MH1	MH2	1.20	25.76	25.76	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	25.77	7.93	HGL Too High!
P7	MH2	MH3	1.20	25.73	25.73	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	25.76	7.65	HGL Too High!
P10	MH3	MH4	1.20	25.66	25.66	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	25.73	7.28	HGL Too High!
P13	MH4	MH5	1.20	25.45	25.45	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	25.66	7.09	HGL Too High!
P15	MH5	MH20	1.60	25.18	25.18	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	25.45	7.40	HGL Too High!
P6	DI16	MH2	1.00	25.76	25.76	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.76	7.33	HGL Too High!
P9	DI3	MH3	1.00	25.73	25.73	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.74	6.62	HGL Too High!
P8	DI17	MH3	1.00	25.73	25.73	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.74	6.96	HGL Too High!
P12	DI4	MH4	1.00	25.66	25.66	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.68	6.48	HGL Too High!
P11	DI18	MH4	1.00	25.66	25.66	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.68	6.56	HGL Too High!
P14	DI5	MH5	1.00	25.45	25.45	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.46	6.61	HGL Too High!
P18	DI6	MH6	1.00	25.47	25.47	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	25.49	7.13	HGL Too High!
P16	MH6	MH5	1.20	25.45	25.45	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	25.47	7.55	HGL Too High!
P17	DI19	MH6	1.00	25.47	25.47	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.48	7.08	HGL Too High!
P32	DI23	MH12	1.00	27.79	27.79	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.80	4.24	HGL Too High!
P31	DI9	MH12	1.00	27.79	27.79	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.79	7.13	HGL Too High!
P30	MH12	MH11	1.60	27.77	27.77	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	27.79	7.48	HGL Too High!
P27	MH11	MH10	1.60	27.68	27.68	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	27.77	7.21	HGL Too High!
P25	MH10	MH9	1.60	27.64	27.64	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	27.68	7.54	HGL Too High!
P22	MH9	MH8	1.60	27.57	27.57	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	27.64	7.85	HGL Too High!
P20	MH8	MH21	1.60	27.49	27.49	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	27.57	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	27.43	27.43	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	27.49	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	27.43	27.43	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	27.48	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	27.57	27.57	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	27.61	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	27.83	27.83	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	28.11	4.78	HGL Too High!
P51	STUB	DI22	1.00	27.83	27.83	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	27.87	7.16	HGL Too High!
P28	DI22	MH11	1.00	27.77	27.77	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	27.83	6.74	HGL Too High!
P29	DI8	MH11	1.00	27.77	27.77	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.77	6.92	HGL Too High!
P26	DI21	MH10	1.00	27.68	27.68	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.68	7.23	HGL Too High!
P23	DI20	MH9	1.00	27.64	27.64	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	27.65	7.38	HGL Too High!
P24	DI7	MH9	1.00	27.64	27.64	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.65	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	69.74	69.74	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	69.75	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	69.74	69.74	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	69.76	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	69.58	69.58	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	69.74	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	69.37	69.37	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	69.58	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	68.37	68.37	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	69.37	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	67.73	67.73	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	68.37	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	54.31	54.31	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	67.73	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	45.11	45.11	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	54.31	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	29.39	29.39	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	45.11	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	27.43	27.43	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	29.39	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	25.18	25.18	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	27.43	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	24.26	24.26	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	25.18	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	17.16	17.16	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	24.26	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.09	12.09	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	17.16	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.50**	**9.50**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**12.09**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	71.70	71.70	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	80.57	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	71.70	71.70	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	71.73	6.45	HGL Too High!
P3	DI14	DI13	1.00	71.70	71.70	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	71.71	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	69.58	69.58	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	71.70	6.58	HGL Too High!
P2	DI2	DI1	1.00	69.38	69.38	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	69.39	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	69.37	69.37	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	69.38	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	72.26	72.26	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	72.28	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	72.26	72.26	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	73.84	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	67.73	67.73	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	72.26	8.13	HGL Too High!
P42	DI31	MH22	1.00	55.37	55.37	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	55.44	5.12	HGL Too High!
P43	MH22	DI32	1.00	55.32	55.32	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	55.37	5.45	HGL Too High!
P44	DI32	EX	1.00	54.31	54.31	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	55.32	5.23	HGL Too High!
P46	DI34	DI33	1.00	55.44	55.44	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	55.44	5.47	HGL Too High!
P45	DI33	DI32	1.00	55.32	55.32	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	55.44	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	29.39	29.39	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	29.39	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	68.18	68.18	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	68.37	3.63	HGL Too High!
P48	DI40	DI41	0.80	68.18	68.18	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	68.20	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	67.73	67.73	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	68.18	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	27.07	27.07	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.08	7.41	
P5	MH1	MH2	1.20	27.06	27.06	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	27.07	7.93	HGL Too High!
P7	MH2	MH3	1.20	27.03	27.03	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	27.06	7.65	HGL Too High!
P10	MH3	MH4	1.20	26.96	26.96	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	27.03	7.28	HGL Too High!
P13	MH4	MH5	1.20	26.75	26.75	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	26.96	7.09	HGL Too High!
P15	MH5	MH20	1.60	26.48	26.48	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	26.75	7.40	HGL Too High!
P6	DI16	MH2	1.00	27.06	27.06	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.06	7.33	HGL Too High!
P9	DI3	MH3	1.00	27.03	27.03	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.04	6.62	HGL Too High!
P8	DI17	MH3	1.00	27.03	27.03	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.04	6.96	HGL Too High!
P12	DI4	MH4	1.00	26.96	26.96	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.98	6.48	HGL Too High!
P11	DI18	MH4	1.00	26.96	26.96	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.98	6.56	HGL Too High!
P14	DI5	MH5	1.00	26.75	26.75	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.76	6.61	HGL Too High!
P18	DI6	MH6	1.00	26.77	26.77	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	26.79	7.13	HGL Too High!
P16	MH6	MH5	1.20	26.75	26.75	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	26.77	7.55	HGL Too High!
P17	DI19	MH6	1.00	26.77	26.77	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.78	7.08	HGL Too High!
P32	DI23	MH12	1.00	29.09	29.09	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.10	4.24	HGL Too High!
P31	DI9	MH12	1.00	29.09	29.09	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.09	7.13	HGL Too High!
P30	MH12	MH11	1.60	29.07	29.07	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	29.09	7.48	HGL Too High!
P27	MH11	MH10	1.60	28.98	28.98	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	29.07	7.21	HGL Too High!
P25	MH10	MH9	1.60	28.94	28.94	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	28.98	7.54	HGL Too High!
P22	MH9	MH8	1.60	28.87	28.87	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	28.94	7.85	HGL Too High!
P20	MH8	MH21	1.60	28.79	28.79	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	28.87	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	28.73	28.73	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	28.79	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	28.73	28.73	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	28.78	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	28.87	28.87	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	28.91	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	29.13	29.13	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	29.41	4.78	HGL Too High!
P51	STUB	DI22	1.00	29.13	29.13	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	29.17	7.16	HGL Too High!
P28	DI22	MH11	1.00	29.07	29.07	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	29.13	6.74	HGL Too High!
P29	DI8	MH11	1.00	29.07	29.07	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.07	6.92	HGL Too High!
P26	DI21	MH10	1.00	28.98	28.98	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.98	7.23	HGL Too High!
P23	DI20	MH9	1.00	28.94	28.94	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	28.95	7.38	HGL Too High!
P24	DI7	MH9	1.00	28.94	28.94	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.95	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	71.04	71.04	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	71.05	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	71.04	71.04	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	71.06	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	70.88	70.88	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	71.04	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	70.67	70.67	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	70.88	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	69.67	69.67	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	70.67	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	69.03	69.03	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	69.67	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	55.61	55.61	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	69.03	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	46.41	46.41	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	55.61	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	30.69	30.69	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	46.41	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	28.73	28.73	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	30.69	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	26.48	26.48	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	28.73	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	25.56	25.56	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	26.48	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	18.46	18.46	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	25.56	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.39	13.39	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	18.46	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.80**	**10.80**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**13.39**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	73.00	73.00	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	81.87	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	73.00	73.00	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	73.03	6.45	HGL Too High!
P3	DI14	DI13	1.00	73.00	73.00	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	73.01	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	70.88	70.88	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	73.00	6.58	HGL Too High!
P2	DI2	DI1	1.00	70.68	70.68	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	70.69	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	70.67	70.67	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	70.68	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	73.56	73.56	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	73.58	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	73.56	73.56	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	75.14	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	69.03	69.03	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	73.56	8.13	HGL Too High!
P42	DI31	MH22	1.00	56.67	56.67	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	56.74	5.12	HGL Too High!
P43	MH22	DI32	1.00	56.62	56.62	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	56.67	5.45	HGL Too High!
P44	DI32	EX	1.00	55.61	55.61	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	56.62	5.23	HGL Too High!
P46	DI34	DI33	1.00	56.74	56.74	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	56.74	5.47	HGL Too High!
P45	DI33	DI32	1.00	56.62	56.62	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	56.74	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	30.69	30.69	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	30.69	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	69.48	69.48	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	69.67	3.63	HGL Too High!
P48	DI40	DI41	0.80	69.48	69.48	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	69.50	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	69.03	69.03	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	69.48	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	22.01	22.01	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.02	7.41	
P5	MH1	MH2	1.20	22.00	22.00	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	22.01	7.93	HGL Too High!
P7	MH2	MH3	1.20	21.97	21.97	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	22.00	7.65	HGL Too High!
P10	MH3	MH4	1.20	21.90	21.90	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	21.97	7.28	HGL Too High!
P13	MH4	MH5	1.20	21.69	21.69	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	21.90	7.09	HGL Too High!
P15	MH5	MH20	1.60	21.42	21.42	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	21.69	7.40	HGL Too High!
P6	DI16	MH2	1.00	22.00	22.00	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.00	7.33	HGL Too High!
P9	DI3	MH3	1.00	21.97	21.97	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.98	6.62	HGL Too High!
P8	DI17	MH3	1.00	21.97	21.97	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.98	6.96	HGL Too High!
P12	DI4	MH4	1.00	21.90	21.90	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.92	6.48	HGL Too High!
P11	DI18	MH4	1.00	21.90	21.90	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.92	6.56	HGL Too High!
P14	DI5	MH5	1.00	21.69	21.69	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.70	6.61	HGL Too High!
P18	DI6	MH6	1.00	21.71	21.71	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	21.73	7.13	HGL Too High!
P16	MH6	MH5	1.20	21.69	21.69	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	21.71	7.55	HGL Too High!
P17	DI19	MH6	1.00	21.71	21.71	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.72	7.08	HGL Too High!
P32	DI23	MH12	1.00	24.03	24.03	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.04	4.24	HGL Too High!
P31	DI9	MH12	1.00	24.03	24.03	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.03	7.13	HGL Too High!
P30	MH12	MH11	1.60	24.01	24.01	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	24.03	7.48	HGL Too High!
P27	MH11	MH10	1.60	23.92	23.92	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	24.01	7.21	HGL Too High!
P25	MH10	MH9	1.60	23.88	23.88	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	23.92	7.54	HGL Too High!
P22	MH9	MH8	1.60	23.81	23.81	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	23.88	7.85	HGL Too High!
P20	MH8	MH21	1.60	23.73	23.73	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	23.81	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	23.67	23.67	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	23.73	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	23.67	23.67	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	23.72	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	23.81	23.81	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	23.85	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	24.07	24.07	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	24.35	4.78	HGL Too High!
P51	STUB	DI22	1.00	24.07	24.07	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	24.11	7.16	HGL Too High!
P28	DI22	MH11	1.00	24.01	24.01	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	24.07	6.74	HGL Too High!
P29	DI8	MH11	1.00	24.01	24.01	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.01	6.92	HGL Too High!
P26	DI21	MH10	1.00	23.92	23.92	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.92	7.23	HGL Too High!
P23	DI20	MH9	1.00	23.88	23.88	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	23.89	7.38	HGL Too High!
P24	DI7	MH9	1.00	23.88	23.88	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.89	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	65.98	65.98	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	65.99	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	65.98	65.98	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	66.00	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	65.82	65.82	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	65.98	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	65.61	65.61	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	65.82	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	64.61	64.61	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	65.61	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	63.97	63.97	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	64.61	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	50.55	50.55	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	63.97	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	41.35	41.35	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	50.55	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	25.63	25.63	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	41.35	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	23.67	23.67	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	25.63	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	21.42	21.42	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	23.67	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	20.50	20.50	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	21.42	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.40	13.40	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	20.50	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	8.33	8.33	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	13.40	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.74**	**5.74**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**8.33**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	67.94	67.94	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	76.81	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	67.94	67.94	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	67.97	6.45	HGL Too High!
P3	DI14	DI13	1.00	67.94	67.94	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	67.95	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	65.82	65.82	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	67.94	6.58	HGL Too High!
P2	DI2	DI1	1.00	65.62	65.62	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	65.63	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	65.61	65.61	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	65.62	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	68.50	68.50	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	68.52	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	68.50	68.50	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	70.08	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	63.97	63.97	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	68.50	8.13	HGL Too High!
P42	DI31	MH22	1.00	51.61	51.61	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	51.68	5.12	HGL Too High!
P43	MH22	DI32	1.00	51.56	51.56	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	51.61	5.45	HGL Too High!
P44	DI32	EX	1.00	50.55	50.55	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	51.56	5.23	HGL Too High!
P46	DI34	DI33	1.00	51.68	51.68	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	51.68	5.47	HGL Too High!
P45	DI33	DI32	1.00	51.56	51.56	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	51.68	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	25.63	25.63	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	25.63	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	64.42	64.42	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	64.61	3.63	HGL Too High!
P48	DI40	DI41	0.80	64.42	64.42	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	64.44	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	63.97	63.97	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	64.42	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	22.21	22.21	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.22	7.41	
P5	MH1	MH2	1.20	22.20	22.20	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	22.21	7.93	HGL Too High!
P7	MH2	MH3	1.20	22.17	22.17	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	22.20	7.65	HGL Too High!
P10	MH3	MH4	1.20	22.10	22.10	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	22.17	7.28	HGL Too High!
P13	MH4	MH5	1.20	21.89	21.89	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	22.10	7.09	HGL Too High!
P15	MH5	MH20	1.60	21.62	21.62	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	21.89	7.40	HGL Too High!
P6	DI16	MH2	1.00	22.20	22.20	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.20	7.33	HGL Too High!
P9	DI3	MH3	1.00	22.17	22.17	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.18	6.62	HGL Too High!
P8	DI17	MH3	1.00	22.17	22.17	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.18	6.96	HGL Too High!
P12	DI4	MH4	1.00	22.10	22.10	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.12	6.48	HGL Too High!
P11	DI18	MH4	1.00	22.10	22.10	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.12	6.56	HGL Too High!
P14	DI5	MH5	1.00	21.89	21.89	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.90	6.61	HGL Too High!
P18	DI6	MH6	1.00	21.91	21.91	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	21.93	7.13	HGL Too High!
P16	MH6	MH5	1.20	21.89	21.89	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	21.91	7.55	HGL Too High!
P17	DI19	MH6	1.00	21.91	21.91	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.92	7.08	HGL Too High!
P32	DI23	MH12	1.00	24.23	24.23	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.24	4.24	HGL Too High!
P31	DI9	MH12	1.00	24.23	24.23	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.23	7.13	HGL Too High!
P30	MH12	MH11	1.60	24.21	24.21	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	24.23	7.48	HGL Too High!
P27	MH11	MH10	1.60	24.12	24.12	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	24.21	7.21	HGL Too High!
P25	MH10	MH9	1.60	24.08	24.08	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	24.12	7.54	HGL Too High!
P22	MH9	MH8	1.60	24.01	24.01	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	24.08	7.85	HGL Too High!
P20	MH8	MH21	1.60	23.93	23.93	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	24.01	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	23.87	23.87	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	23.93	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	23.87	23.87	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	23.92	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	24.01	24.01	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	24.05	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	24.27	24.27	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	24.55	4.78	HGL Too High!
P51	STUB	DI22	1.00	24.27	24.27	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	24.31	7.16	HGL Too High!
P28	DI22	MH11	1.00	24.21	24.21	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	24.27	6.74	HGL Too High!
P29	DI8	MH11	1.00	24.21	24.21	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.21	6.92	HGL Too High!
P26	DI21	MH10	1.00	24.12	24.12	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.12	7.23	HGL Too High!
P23	DI20	MH9	1.00	24.08	24.08	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	24.09	7.38	HGL Too High!
P24	DI7	MH9	1.00	24.08	24.08	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.09	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	66.18	66.18	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	66.19	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	66.18	66.18	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	66.20	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	66.02	66.02	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	66.18	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	65.81	65.81	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	66.02	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	64.81	64.81	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	65.81	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	64.17	64.17	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	64.81	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	50.75	50.75	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	64.17	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	41.55	41.55	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	50.75	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	25.83	25.83	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	41.55	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	23.87	23.87	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	25.83	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	21.62	21.62	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	23.87	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	20.70	20.70	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	21.62	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.60	13.60	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	20.70	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	8.53	8.53	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	13.60	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.94**	**5.94**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**8.53**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	68.14	68.14	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	77.01	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	68.14	68.14	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	68.17	6.45	HGL Too High!
P3	DI14	DI13	1.00	68.14	68.14	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	68.15	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	66.02	66.02	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	68.14	6.58	HGL Too High!
P2	DI2	DI1	1.00	65.82	65.82	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	65.83	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	65.81	65.81	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	65.82	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	68.70	68.70	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	68.72	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	68.70	68.70	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	70.28	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	64.17	64.17	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	68.70	8.13	HGL Too High!
P42	DI31	MH22	1.00	51.81	51.81	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	51.88	5.12	HGL Too High!
P43	MH22	DI32	1.00	51.76	51.76	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	51.81	5.45	HGL Too High!
P44	DI32	EX	1.00	50.75	50.75	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	51.76	5.23	HGL Too High!
P46	DI34	DI33	1.00	51.88	51.88	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	51.88	5.47	HGL Too High!
P45	DI33	DI32	1.00	51.76	51.76	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	51.88	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	25.83	25.83	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	25.83	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	64.62	64.62	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	64.81	3.63	HGL Too High!
P48	DI40	DI41	0.80	64.62	64.62	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	64.64	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	64.17	64.17	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	64.62	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	25.71	25.71	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.72	7.41	
P5	MH1	MH2	1.20	25.70	25.70	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	25.71	7.93	HGL Too High!
P7	MH2	MH3	1.20	25.67	25.67	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	25.70	7.65	HGL Too High!
P10	MH3	MH4	1.20	25.60	25.60	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	25.67	7.28	HGL Too High!
P13	MH4	MH5	1.20	25.39	25.39	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	25.60	7.09	HGL Too High!
P15	MH5	MH20	1.60	25.12	25.12	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	25.39	7.40	HGL Too High!
P6	DI16	MH2	1.00	25.70	25.70	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.70	7.33	HGL Too High!
P9	DI3	MH3	1.00	25.67	25.67	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.68	6.62	HGL Too High!
P8	DI17	MH3	1.00	25.67	25.67	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.68	6.96	HGL Too High!
P12	DI4	MH4	1.00	25.60	25.60	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.62	6.48	HGL Too High!
P11	DI18	MH4	1.00	25.60	25.60	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.62	6.56	HGL Too High!
P14	DI5	MH5	1.00	25.39	25.39	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.40	6.61	HGL Too High!
P18	DI6	MH6	1.00	25.41	25.41	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	25.43	7.13	HGL Too High!
P16	MH6	MH5	1.20	25.39	25.39	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	25.41	7.55	HGL Too High!
P17	DI19	MH6	1.00	25.41	25.41	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.42	7.08	HGL Too High!
P32	DI23	MH12	1.00	27.73	27.73	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.74	4.24	HGL Too High!
P31	DI9	MH12	1.00	27.73	27.73	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.73	7.13	HGL Too High!
P30	MH12	MH11	1.60	27.71	27.71	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	27.73	7.48	HGL Too High!
P27	MH11	MH10	1.60	27.62	27.62	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	27.71	7.21	HGL Too High!
P25	MH10	MH9	1.60	27.58	27.58	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	27.62	7.54	HGL Too High!
P22	MH9	MH8	1.60	27.51	27.51	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	27.58	7.85	HGL Too High!
P20	MH8	MH21	1.60	27.43	27.43	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	27.51	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	27.37	27.37	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	27.43	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	27.37	27.37	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	27.42	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	27.51	27.51	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	27.55	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	27.77	27.77	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	28.05	4.78	HGL Too High!
P51	STUB	DI22	1.00	27.77	27.77	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	27.81	7.16	HGL Too High!
P28	DI22	MH11	1.00	27.71	27.71	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	27.77	6.74	HGL Too High!
P29	DI8	MH11	1.00	27.71	27.71	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.71	6.92	HGL Too High!
P26	DI21	MH10	1.00	27.62	27.62	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.62	7.23	HGL Too High!
P23	DI20	MH9	1.00	27.58	27.58	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	27.59	7.38	HGL Too High!
P24	DI7	MH9	1.00	27.58	27.58	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.59	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	69.68	69.68	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	69.69	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	69.68	69.68	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	69.70	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	69.52	69.52	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	69.68	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	69.31	69.31	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	69.52	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	68.31	68.31	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	69.31	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	67.67	67.67	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	68.31	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	54.25	54.25	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	67.67	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	45.05	45.05	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	54.25	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	29.33	29.33	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	45.05	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	27.37	27.37	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	29.33	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	25.12	25.12	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	27.37	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	24.20	24.20	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	25.12	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	17.10	17.10	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	24.20	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.03	12.03	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	17.10	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.44**	**9.44**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**12.03**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	71.64	71.64	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	80.51	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	71.64	71.64	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	71.67	6.45	HGL Too High!
P3	DI14	DI13	1.00	71.64	71.64	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	71.65	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	69.52	69.52	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	71.64	6.58	HGL Too High!
P2	DI2	DI1	1.00	69.32	69.32	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	69.33	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	69.31	69.31	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	69.32	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	72.20	72.20	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	72.22	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	72.20	72.20	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	73.78	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	67.67	67.67	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	72.20	8.13	HGL Too High!
P42	DI31	MH22	1.00	55.31	55.31	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	55.38	5.12	HGL Too High!
P43	MH22	DI32	1.00	55.26	55.26	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	55.31	5.45	HGL Too High!
P44	DI32	EX	1.00	54.25	54.25	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	55.26	5.23	HGL Too High!
P46	DI34	DI33	1.00	55.38	55.38	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	55.38	5.47	HGL Too High!
P45	DI33	DI32	1.00	55.26	55.26	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	55.38	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	29.33	29.33	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	29.33	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	68.12	68.12	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	68.31	3.63	HGL Too High!
P48	DI40	DI41	0.80	68.12	68.12	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	68.14	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	67.67	67.67	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	68.12	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	26.21	26.21	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.22	7.41	
P5	MH1	MH2	1.20	26.20	26.20	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	26.21	7.93	HGL Too High!
P7	MH2	MH3	1.20	26.17	26.17	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	26.20	7.65	HGL Too High!
P10	MH3	MH4	1.20	26.10	26.10	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	26.17	7.28	HGL Too High!
P13	MH4	MH5	1.20	25.89	25.89	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	26.10	7.09	HGL Too High!
P15	MH5	MH20	1.60	25.62	25.62	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	25.89	7.40	HGL Too High!
P6	DI16	MH2	1.00	26.20	26.20	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.20	7.33	HGL Too High!
P9	DI3	MH3	1.00	26.17	26.17	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.18	6.62	HGL Too High!
P8	DI17	MH3	1.00	26.17	26.17	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.18	6.96	HGL Too High!
P12	DI4	MH4	1.00	26.10	26.10	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.12	6.48	HGL Too High!
P11	DI18	MH4	1.00	26.10	26.10	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.12	6.56	HGL Too High!
P14	DI5	MH5	1.00	25.89	25.89	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.90	6.61	HGL Too High!
P18	DI6	MH6	1.00	25.91	25.91	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	25.93	7.13	HGL Too High!
P16	MH6	MH5	1.20	25.89	25.89	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	25.91	7.55	HGL Too High!
P17	DI19	MH6	1.00	25.91	25.91	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.92	7.08	HGL Too High!
P32	DI23	MH12	1.00	28.23	28.23	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.24	4.24	HGL Too High!
P31	DI9	MH12	1.00	28.23	28.23	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.23	7.13	HGL Too High!
P30	MH12	MH11	1.60	28.21	28.21	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	28.23	7.48	HGL Too High!
P27	MH11	MH10	1.60	28.12	28.12	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	28.21	7.21	HGL Too High!
P25	MH10	MH9	1.60	28.08	28.08	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	28.12	7.54	HGL Too High!
P22	MH9	MH8	1.60	28.01	28.01	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	28.08	7.85	HGL Too High!
P20	MH8	MH21	1.60	27.93	27.93	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	28.01	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	27.87	27.87	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	27.93	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	27.87	27.87	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	27.92	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	28.01	28.01	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	28.05	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	28.27	28.27	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	28.55	4.78	HGL Too High!
P51	STUB	DI22	1.00	28.27	28.27	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	28.31	7.16	HGL Too High!
P28	DI22	MH11	1.00	28.21	28.21	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	28.27	6.74	HGL Too High!
P29	DI8	MH11	1.00	28.21	28.21	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.21	6.92	HGL Too High!
P26	DI21	MH10	1.00	28.12	28.12	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.12	7.23	HGL Too High!
P23	DI20	MH9	1.00	28.08	28.08	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	28.09	7.38	HGL Too High!
P24	DI7	MH9	1.00	28.08	28.08	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.09	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	70.18	70.18	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	70.19	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	70.18	70.18	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	70.20	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	70.02	70.02	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	70.18	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	69.81	69.81	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	70.02	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	68.81	68.81	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	69.81	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	68.17	68.17	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	68.81	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	54.75	54.75	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	68.17	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	45.55	45.55	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	54.75	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	29.83	29.83	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	45.55	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	27.87	27.87	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	29.83	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	25.62	25.62	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	27.87	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	24.70	24.70	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	25.62	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	17.60	17.60	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	24.70	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.53	12.53	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	17.60	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.94**	**9.94**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**12.53**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	72.14	72.14	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	81.01	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	72.14	72.14	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	72.17	6.45	HGL Too High!
P3	DI14	DI13	1.00	72.14	72.14	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	72.15	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	70.02	70.02	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	72.14	6.58	HGL Too High!
P2	DI2	DI1	1.00	69.82	69.82	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	69.83	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	69.81	69.81	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	69.82	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	72.70	72.70	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	72.72	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	72.70	72.70	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	74.28	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	68.17	68.17	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	72.70	8.13	HGL Too High!
P42	DI31	MH22	1.00	55.81	55.81	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	55.88	5.12	HGL Too High!
P43	MH22	DI32	1.00	55.76	55.76	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	55.81	5.45	HGL Too High!
P44	DI32	EX	1.00	54.75	54.75	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	55.76	5.23	HGL Too High!
P46	DI34	DI33	1.00	55.88	55.88	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	55.88	5.47	HGL Too High!
P45	DI33	DI32	1.00	55.76	55.76	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	55.88	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	29.83	29.83	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	29.83	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	68.62	68.62	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	68.81	3.63	HGL Too High!
P48	DI40	DI41	0.80	68.62	68.62	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	68.64	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	68.17	68.17	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	68.62	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	26.61	26.61	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.62	7.41	
P5	MH1	MH2	1.20	26.60	26.60	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	26.61	7.93	HGL Too High!
P7	MH2	MH3	1.20	26.57	26.57	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	26.60	7.65	HGL Too High!
P10	MH3	MH4	1.20	26.50	26.50	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	26.57	7.28	HGL Too High!
P13	MH4	MH5	1.20	26.29	26.29	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	26.50	7.09	HGL Too High!
P15	MH5	MH20	1.60	26.02	26.02	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	26.29	7.40	HGL Too High!
P6	DI16	MH2	1.00	26.60	26.60	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.60	7.33	HGL Too High!
P9	DI3	MH3	1.00	26.57	26.57	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.58	6.62	HGL Too High!
P8	DI17	MH3	1.00	26.57	26.57	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.58	6.96	HGL Too High!
P12	DI4	MH4	1.00	26.50	26.50	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.52	6.48	HGL Too High!
P11	DI18	MH4	1.00	26.50	26.50	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.52	6.56	HGL Too High!
P14	DI5	MH5	1.00	26.29	26.29	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.30	6.61	HGL Too High!
P18	DI6	MH6	1.00	26.31	26.31	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	26.33	7.13	HGL Too High!
P16	MH6	MH5	1.20	26.29	26.29	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	26.31	7.55	HGL Too High!
P17	DI19	MH6	1.00	26.31	26.31	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.32	7.08	HGL Too High!
P32	DI23	MH12	1.00	28.63	28.63	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.64	4.24	HGL Too High!
P31	DI9	MH12	1.00	28.63	28.63	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.63	7.13	HGL Too High!
P30	MH12	MH11	1.60	28.61	28.61	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	28.63	7.48	HGL Too High!
P27	MH11	MH10	1.60	28.52	28.52	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	28.61	7.21	HGL Too High!
P25	MH10	MH9	1.60	28.48	28.48	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	28.52	7.54	HGL Too High!
P22	MH9	MH8	1.60	28.41	28.41	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	28.48	7.85	HGL Too High!
P20	MH8	MH21	1.60	28.33	28.33	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	28.41	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	28.27	28.27	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	28.33	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	28.27	28.27	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	28.32	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	28.41	28.41	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	28.45	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	28.67	28.67	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	28.95	4.78	HGL Too High!
P51	STUB	DI22	1.00	28.67	28.67	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	28.71	7.16	HGL Too High!
P28	DI22	MH11	1.00	28.61	28.61	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	28.67	6.74	HGL Too High!
P29	DI8	MH11	1.00	28.61	28.61	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.61	6.92	HGL Too High!
P26	DI21	MH10	1.00	28.52	28.52	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.52	7.23	HGL Too High!
P23	DI20	MH9	1.00	28.48	28.48	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	28.49	7.38	HGL Too High!
P24	DI7	MH9	1.00	28.48	28.48	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.49	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	70.58	70.58	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	70.59	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	70.58	70.58	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	70.60	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	70.42	70.42	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	70.58	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	70.21	70.21	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	70.42	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	69.21	69.21	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	70.21	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	68.57	68.57	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	69.21	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	55.15	55.15	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	68.57	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	45.95	45.95	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	55.15	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	30.23	30.23	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	45.95	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	28.27	28.27	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	30.23	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	26.02	26.02	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	28.27	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	25.10	25.10	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	26.02	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	18.00	18.00	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	25.10	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.93	12.93	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	18.00	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.34**	**10.34**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**12.93**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	72.54	72.54	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	81.41	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	72.54	72.54	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	72.57	6.45	HGL Too High!
P3	DI14	DI13	1.00	72.54	72.54	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	72.55	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	70.42	70.42	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	72.54	6.58	HGL Too High!
P2	DI2	DI1	1.00	70.22	70.22	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	70.23	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	70.21	70.21	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	70.22	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	73.10	73.10	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	73.12	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	73.10	73.10	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	74.68	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	68.57	68.57	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	73.10	8.13	HGL Too High!
P42	DI31	MH22	1.00	56.21	56.21	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	56.28	5.12	HGL Too High!
P43	MH22	DI32	1.00	56.16	56.16	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	56.21	5.45	HGL Too High!
P44	DI32	EX	1.00	55.15	55.15	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	56.16	5.23	HGL Too High!
P46	DI34	DI33	1.00	56.28	56.28	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	56.28	5.47	HGL Too High!
P45	DI33	DI32	1.00	56.16	56.16	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	56.28	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	30.23	30.23	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	30.23	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	69.02	69.02	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	69.21	3.63	HGL Too High!
P48	DI40	DI41	0.80	69.02	69.02	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	69.04	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	68.57	68.57	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	69.02	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	27.11	27.11	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.12	7.41	
P5	MH1	MH2	1.20	27.10	27.10	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	27.11	7.93	HGL Too High!
P7	MH2	MH3	1.20	27.07	27.07	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	27.10	7.65	HGL Too High!
P10	MH3	MH4	1.20	27.00	27.00	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	27.07	7.28	HGL Too High!
P13	MH4	MH5	1.20	26.79	26.79	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	27.00	7.09	HGL Too High!
P15	MH5	MH20	1.60	26.52	26.52	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	26.79	7.40	HGL Too High!
P6	DI16	MH2	1.00	27.10	27.10	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.10	7.33	HGL Too High!
P9	DI3	MH3	1.00	27.07	27.07	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.08	6.62	HGL Too High!
P8	DI17	MH3	1.00	27.07	27.07	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.08	6.96	HGL Too High!
P12	DI4	MH4	1.00	27.00	27.00	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.02	6.48	HGL Too High!
P11	DI18	MH4	1.00	27.00	27.00	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.02	6.56	HGL Too High!
P14	DI5	MH5	1.00	26.79	26.79	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.80	6.61	HGL Too High!
P18	DI6	MH6	1.00	26.81	26.81	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	26.83	7.13	HGL Too High!
P16	MH6	MH5	1.20	26.79	26.79	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	26.81	7.55	HGL Too High!
P17	DI19	MH6	1.00	26.81	26.81	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.82	7.08	HGL Too High!
P32	DI23	MH12	1.00	29.13	29.13	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.14	4.24	HGL Too High!
P31	DI9	MH12	1.00	29.13	29.13	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.13	7.13	HGL Too High!
P30	MH12	MH11	1.60	29.11	29.11	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	29.13	7.48	HGL Too High!
P27	MH11	MH10	1.60	29.02	29.02	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	29.11	7.21	HGL Too High!
P25	MH10	MH9	1.60	28.98	28.98	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	29.02	7.54	HGL Too High!
P22	MH9	MH8	1.60	28.91	28.91	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	28.98	7.85	HGL Too High!
P20	MH8	MH21	1.60	28.83	28.83	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	28.91	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	28.77	28.77	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	28.83	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	28.77	28.77	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	28.82	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	28.91	28.91	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	28.95	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	29.17	29.17	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	29.45	4.78	HGL Too High!
P51	STUB	DI22	1.00	29.17	29.17	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	29.21	7.16	HGL Too High!
P28	DI22	MH11	1.00	29.11	29.11	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	29.17	6.74	HGL Too High!
P29	DI8	MH11	1.00	29.11	29.11	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.11	6.92	HGL Too High!
P26	DI21	MH10	1.00	29.02	29.02	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.02	7.23	HGL Too High!
P23	DI20	MH9	1.00	28.98	28.98	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	28.99	7.38	HGL Too High!
P24	DI7	MH9	1.00	28.98	28.98	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.99	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	71.08	71.08	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	71.09	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	71.08	71.08	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	71.10	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	70.92	70.92	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	71.08	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	70.71	70.71	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	70.92	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	69.71	69.71	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	70.71	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	69.07	69.07	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	69.71	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	55.65	55.65	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	69.07	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	46.45	46.45	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	55.65	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	30.73	30.73	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	46.45	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	28.77	28.77	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	30.73	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	26.52	26.52	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	28.77	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	25.60	25.60	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	26.52	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	18.50	18.50	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	25.60	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.43	13.43	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	18.50	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.84**	**10.84**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**13.43**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	73.04	73.04	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	81.91	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	73.04	73.04	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	73.07	6.45	HGL Too High!
P3	DI14	DI13	1.00	73.04	73.04	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	73.05	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	70.92	70.92	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	73.04	6.58	HGL Too High!
P2	DI2	DI1	1.00	70.72	70.72	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	70.73	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	70.71	70.71	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	70.72	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	73.60	73.60	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	73.62	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	73.60	73.60	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	75.18	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	69.07	69.07	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	73.60	8.13	HGL Too High!
P42	DI31	MH22	1.00	56.71	56.71	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	56.78	5.12	HGL Too High!
P43	MH22	DI32	1.00	56.66	56.66	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	56.71	5.45	HGL Too High!
P44	DI32	EX	1.00	55.65	55.65	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	56.66	5.23	HGL Too High!
P46	DI34	DI33	1.00	56.78	56.78	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	56.78	5.47	HGL Too High!
P45	DI33	DI32	1.00	56.66	56.66	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	56.78	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	30.73	30.73	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	30.73	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	69.52	69.52	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	69.71	3.63	HGL Too High!
P48	DI40	DI41	0.80	69.52	69.52	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	69.54	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	69.07	69.07	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	69.52	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	27.81	27.81	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.82	7.41	
P5	MH1	MH2	1.20	27.80	27.80	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	27.81	7.93	HGL Too High!
P7	MH2	MH3	1.20	27.77	27.77	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	27.80	7.65	HGL Too High!
P10	MH3	MH4	1.20	27.70	27.70	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	27.77	7.28	HGL Too High!
P13	MH4	MH5	1.20	27.49	27.49	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	27.70	7.09	HGL Too High!
P15	MH5	MH20	1.60	27.22	27.22	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	27.49	7.40	HGL Too High!
P6	DI16	MH2	1.00	27.80	27.80	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.80	7.33	HGL Too High!
P9	DI3	MH3	1.00	27.77	27.77	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.78	6.62	HGL Too High!
P8	DI17	MH3	1.00	27.77	27.77	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.78	6.96	HGL Too High!
P12	DI4	MH4	1.00	27.70	27.70	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.72	6.48	HGL Too High!
P11	DI18	MH4	1.00	27.70	27.70	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.72	6.56	HGL Too High!
P14	DI5	MH5	1.00	27.49	27.49	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.50	6.61	HGL Too High!
P18	DI6	MH6	1.00	27.51	27.51	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	27.53	7.13	HGL Too High!
P16	MH6	MH5	1.20	27.49	27.49	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	27.51	7.55	HGL Too High!
P17	DI19	MH6	1.00	27.51	27.51	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.52	7.08	HGL Too High!
P32	DI23	MH12	1.00	29.83	29.83	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.84	4.24	HGL Too High!
P31	DI9	MH12	1.00	29.83	29.83	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.83	7.13	HGL Too High!
P30	MH12	MH11	1.60	29.81	29.81	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	29.83	7.48	HGL Too High!
P27	MH11	MH10	1.60	29.72	29.72	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	29.81	7.21	HGL Too High!
P25	MH10	MH9	1.60	29.68	29.68	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	29.72	7.54	HGL Too High!
P22	MH9	MH8	1.60	29.61	29.61	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	29.68	7.85	HGL Too High!
P20	MH8	MH21	1.60	29.53	29.53	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	29.61	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	29.47	29.47	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	29.53	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	29.47	29.47	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	29.52	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	29.61	29.61	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	29.65	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	29.87	29.87	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	30.15	4.78	HGL Too High!
P51	STUB	DI22	1.00	29.87	29.87	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	29.91	7.16	HGL Too High!
P28	DI22	MH11	1.00	29.81	29.81	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	29.87	6.74	HGL Too High!
P29	DI8	MH11	1.00	29.81	29.81	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.81	6.92	HGL Too High!
P26	DI21	MH10	1.00	29.72	29.72	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.72	7.23	HGL Too High!
P23	DI20	MH9	1.00	29.68	29.68	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	29.69	7.38	HGL Too High!
P24	DI7	MH9	1.00	29.68	29.68	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.69	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	71.78	71.78	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	71.79	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	71.78	71.78	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	71.80	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	71.62	71.62	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	71.78	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	71.41	71.41	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	71.62	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	70.41	70.41	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	71.41	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	69.77	69.77	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	70.41	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	56.35	56.35	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	69.77	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	47.15	47.15	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	56.35	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	31.43	31.43	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	47.15	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	29.47	29.47	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	31.43	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	27.22	27.22	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	29.47	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	26.30	26.30	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	27.22	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	19.20	19.20	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	26.30	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	14.13	14.13	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	19.20	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**11.54**	**11.54**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**14.13**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	73.74	73.74	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	82.61	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	73.74	73.74	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	73.77	6.45	HGL Too High!
P3	DI14	DI13	1.00	73.74	73.74	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	73.75	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	71.62	71.62	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	73.74	6.58	HGL Too High!
P2	DI2	DI1	1.00	71.42	71.42	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	71.43	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	71.41	71.41	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	71.42	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	74.30	74.30	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	74.32	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	74.30	74.30	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	75.88	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	69.77	69.77	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	74.30	8.13	HGL Too High!
P42	DI31	MH22	1.00	57.41	57.41	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	57.48	5.12	HGL Too High!
P43	MH22	DI32	1.00	57.36	57.36	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	57.41	5.45	HGL Too High!
P44	DI32	EX	1.00	56.35	56.35	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	57.36	5.23	HGL Too High!
P46	DI34	DI33	1.00	57.48	57.48	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	57.48	5.47	HGL Too High!
P45	DI33	DI32	1.00	57.36	57.36	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	57.48	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	31.43	31.43	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	31.43	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	70.22	70.22	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	70.41	3.63	HGL Too High!
P48	DI40	DI41	0.80	70.22	70.22	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	70.24	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	69.77	69.77	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	70.22	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	28.31	28.31	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.32	7.41	
P5	MH1	MH2	1.20	28.30	28.30	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	28.31	7.93	HGL Too High!
P7	MH2	MH3	1.20	28.27	28.27	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	28.30	7.65	HGL Too High!
P10	MH3	MH4	1.20	28.20	28.20	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	28.27	7.28	HGL Too High!
P13	MH4	MH5	1.20	27.99	27.99	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	28.20	7.09	HGL Too High!
P15	MH5	MH20	1.60	27.72	27.72	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	27.99	7.40	HGL Too High!
P6	DI16	MH2	1.00	28.30	28.30	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.30	7.33	HGL Too High!
P9	DI3	MH3	1.00	28.27	28.27	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.28	6.62	HGL Too High!
P8	DI17	MH3	1.00	28.27	28.27	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.28	6.96	HGL Too High!
P12	DI4	MH4	1.00	28.20	28.20	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.22	6.48	HGL Too High!
P11	DI18	MH4	1.00	28.20	28.20	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.22	6.56	HGL Too High!
P14	DI5	MH5	1.00	27.99	27.99	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.00	6.61	HGL Too High!
P18	DI6	MH6	1.00	28.01	28.01	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	28.03	7.13	HGL Too High!
P16	MH6	MH5	1.20	27.99	27.99	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	28.01	7.55	HGL Too High!
P17	DI19	MH6	1.00	28.01	28.01	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.02	7.08	HGL Too High!
P32	DI23	MH12	1.00	30.33	30.33	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.34	4.24	HGL Too High!
P31	DI9	MH12	1.00	30.33	30.33	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.33	7.13	HGL Too High!
P30	MH12	MH11	1.60	30.31	30.31	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	30.33	7.48	HGL Too High!
P27	MH11	MH10	1.60	30.22	30.22	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	30.31	7.21	HGL Too High!
P25	MH10	MH9	1.60	30.18	30.18	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	30.22	7.54	HGL Too High!
P22	MH9	MH8	1.60	30.11	30.11	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	30.18	7.85	HGL Too High!
P20	MH8	MH21	1.60	30.03	30.03	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	30.11	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	29.97	29.97	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	30.03	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	29.97	29.97	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	30.02	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	30.11	30.11	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	30.15	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	30.37	30.37	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	30.65	4.78	HGL Too High!
P51	STUB	DI22	1.00	30.37	30.37	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	30.41	7.16	HGL Too High!
P28	DI22	MH11	1.00	30.31	30.31	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	30.37	6.74	HGL Too High!
P29	DI8	MH11	1.00	30.31	30.31	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.31	6.92	HGL Too High!
P26	DI21	MH10	1.00	30.22	30.22	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.22	7.23	HGL Too High!
P23	DI20	MH9	1.00	30.18	30.18	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	30.19	7.38	HGL Too High!
P24	DI7	MH9	1.00	30.18	30.18	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.19	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	72.28	72.28	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	72.29	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	72.28	72.28	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	72.30	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	72.12	72.12	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	72.28	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	71.91	71.91	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	72.12	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	70.91	70.91	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	71.91	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	70.27	70.27	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	70.91	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	56.85	56.85	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	70.27	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	47.65	47.65	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	56.85	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	31.93	31.93	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	47.65	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	29.97	29.97	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	31.93	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	27.72	27.72	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	29.97	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	26.80	26.80	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	27.72	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	19.70	19.70	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	26.80	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	14.63	14.63	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	19.70	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**12.04**	**12.04**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**14.63**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	74.24	74.24	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	83.11	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	74.24	74.24	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	74.27	6.45	HGL Too High!
P3	DI14	DI13	1.00	74.24	74.24	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	74.25	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	72.12	72.12	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	74.24	6.58	HGL Too High!
P2	DI2	DI1	1.00	71.92	71.92	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	71.93	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	71.91	71.91	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	71.92	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	74.80	74.80	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	74.82	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	74.80	74.80	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	76.38	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	70.27	70.27	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	74.80	8.13	HGL Too High!
P42	DI31	MH22	1.00	57.91	57.91	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	57.98	5.12	HGL Too High!
P43	MH22	DI32	1.00	57.86	57.86	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	57.91	5.45	HGL Too High!
P44	DI32	EX	1.00	56.85	56.85	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	57.86	5.23	HGL Too High!
P46	DI34	DI33	1.00	57.98	57.98	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	57.98	5.47	HGL Too High!
P45	DI33	DI32	1.00	57.86	57.86	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	57.98	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	31.93	31.93	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	31.93	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	70.72	70.72	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	70.91	3.63	HGL Too High!
P48	DI40	DI41	0.80	70.72	70.72	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	70.74	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	70.27	70.27	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	70.72	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	29.61	29.61	15	0.7	0.5	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.62	7.41	
P5	MH1	MH2	1.20	29.60	29.60	18	1.3	0.8	0	82.7	0.0001	0.01	0	0.00	0.00	0.4	0.0	0.0	0.5	0.0	90	0.00	0.01	1.3	0.5	0.00	0.02	29.61	7.93	HGL Too High!
P7	MH2	MH3	1.20	29.57	29.57	18	2.0	1.1	1	73.8	0.0003	0.02	0	0.00	0.00	1.0	0.4	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	29.60	7.65	HGL Too High!
P10	MH3	MH4	1.20	29.50	29.50	18	3.6	2.1	8	53.7	0.0010	0.05	0	0.00	0.02	2.3	0.7	0.5	1.1	0.0	1	0.00	0.02	1.0	0.5	0.01	0.07	29.57	7.28	HGL Too High!
P13	MH4	MH5	1.20	29.29	29.29	18	6.2	3.5	84	59.3	0.0030	0.18	0	0.00	0.05	7.4	1.5	1.2	2.1	0.0	8	0.01	0.08	1.0	0.5	0.04	0.22	29.50	7.09	HGL Too High!
P15	MH5	MH20	1.60	29.02	29.02	24	9.3	3.0	90	104	0.0015	0.15	0	0.00	0.03	21.9	3.0	0.9	3.5	0.1	84	0.13	0.23	1.0	0.5	0.12	0.27	29.29	7.40	HGL Too High!
P6	DI16	MH2	1.00	29.60	29.60	15	0.7	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.60	7.33	HGL Too High!
P9	DI3	MH3	1.00	29.57	29.57	15	0.9	0.7	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.58	6.62	HGL Too High!
P8	DI17	MH3	1.00	29.57	29.57	15	0.8	0.7	81	31.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.58	6.96	HGL Too High!
P12	DI4	MH4	1.00	29.50	29.50	15	1.3	1.1	99	20.1	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.52	6.48	HGL Too High!
P11	DI18	MH4	1.00	29.50	29.50	15	1.2	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.52	6.56	HGL Too High!
P14	DI5	MH5	1.00	29.29	29.29	15	1.0	0.8	21	22.6	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.30	6.61	HGL Too High!
P18	DI6	MH6	1.00	29.31	29.31	15	1.4	1.1	23	38	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	29.33	7.13	HGL Too High!
P16	MH6	MH5	1.20	29.29	29.29	18	2.3	1.3	86	40	0.0004	0.02	0	0.00	0.01	1.6	0.7	0.0	1.1	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	29.31	7.55	HGL Too High!
P17	DI19	MH6	1.00	29.31	29.31	15	0.9	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.32	7.08	HGL Too High!
P32	DI23	MH12	1.00	31.63	31.63	15	1.1	0.9	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.64	4.24	HGL Too High!
P31	DI9	MH12	1.00	31.63	31.63	15	0.8	0.7	90	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.63	7.13	HGL Too High!
P30	MH12	MH11	1.60	31.61	31.61	24	1.9	0.6	1	50.1	0.0003	0.01	0	0.00	0.00	0.6	1.0	0.0	0.9	0.0	64	0.01	0.01	1.0	0.5	0.01	0.02	31.63	7.48	HGL Too High!
P27	MH11	MH10	1.60	31.52	31.52	24	4.0	1.3	5	73.2	0.0012	0.09	0	0.00	0.01	1.2	1.0	0.7	0.6	0.0	1	0.00	0.01	1.0	0.5	0.00	0.09	31.61	7.21	HGL Too High!
P25	MH10	MH9	1.60	31.48	31.48	24	4.5	1.4	5	69.7	0.0003	0.02	0	0.00	0.01	5.0	0.3	0.0	1.3	0.0	5	0.00	0.02	1.0	0.5	0.01	0.03	31.52	7.54	HGL Too High!
P22	MH9	MH8	1.60	31.41	31.41	24	5.6	1.8	51	108	0.0005	0.06	0	0.00	0.01	6.3	0.3	0.3	1.4	0.0	5	0.00	0.03	1.0	0.5	0.01	0.07	31.48	7.85	HGL Too High!
P20	MH8	MH21	1.60	31.33	31.33	24	7.1	2.3	90	57.3	0.0008	0.05	0	0.00	0.02	10.2	2.3	0.0	1.8	0.0	51	0.03	0.06	1.0	0.5	0.03	0.08	31.41	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	31.27	31.27	24	7.1	2.3	21	11.3	0.0008	0.01	0	0.00	0.02	16.2	0.0	0.0	2.3	0.0	90	0.06	0.10	1.0	0.5	0.05	0.06	31.33	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	31.27	31.27	18	5.0	2.8	35	7.75	0.0019	0.02	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	26	0.00	0.03	1.0	1.0	0.03	0.05	31.32	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	31.41	31.41	15	1.7	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	31.45	7.34	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	31.67	31.67	8	1.5	4.2	45	17	0.0127	0.22	0	0.00	0.07	0.0	0.0	0.0	0.0	0.0	0	0.00	0.07	1.0	1.0	0.07	0.29	31.95	4.78	HGL Too High!
P51	STUB	DI22	1.00	31.67	31.67	15	3.6	2.9	0	10	0.0026	0.03	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	0.5	0.02	0.04	31.71	7.16	HGL Too High!
P28	DI22	MH11	1.00	31.61	31.61	15	1.1	0.9	90	30.3	0.0003	0.01	0	0.00	0.00	10.4	6.2	0.0	2.9	0.0	0	0.00	0.05	1.0	1.0	0.05	0.06	31.67	6.74	HGL Too High!
P29	DI8	MH11	1.00	31.61	31.61	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.61	6.92	HGL Too High!
P26	DI21	MH10	1.00	31.52	31.52	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.52	7.23	HGL Too High!
P23	DI20	MH9	1.00	31.48	31.48	15	0.7	0.5	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	31.49	7.38	HGL Too High!
P24	DI7	MH9	1.00	31.48	31.48	15	0.6	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.49	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	73.58	73.58	15	1.0	0.8	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	73.59	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	73.58	73.58	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	73.60	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	73.42	73.42	15	2.2	1.8	90	154	0.0010	0.15	0	0.00	0.01	0.8	1.1	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.01	0.16	73.58	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	73.21	73.21	15	5.3	4.3	90	23	0.0068	0.16	0	0.00	0.07	3.9	8.7	0.0	2.7	0.0	0	0.00	0.11	1.0	0.5	0.06	0.21	73.42	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	72.21	72.21	15	6.5	5.3	0	78	0.0101	0.79	0	0.00	0.11	23.2	1.2	0.0	4.3	0.1	90	0.21	0.42	1.0	0.5	0.21	0.99	73.21	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	71.57	71.57	15	6.3	5.1	0	54	0.0095	0.52	0	0.00	0.10	34.3	0.0	0.0	5.3	0.2	0	0.00	0.25	1.0	0.5	0.13	0.64	72.21	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	58.15	58.15	15	14.1	11.5	0	263	0.0473	12.45	0	0.00	0.51	32.5	47.9	13.8	9.4	0.5	90	0.96	1.94	1.0	0.5	0.97	13.42	71.57	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	48.95	48.95	15	19.1	15.6	0	96	0.0873	8.38	0	0.00	0.94	160.9	46.0	0.0	11.5	0.7	0	0.00	1.65	1.0	0.5	0.83	9.21	58.15	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	33.23	33.23	15	18.7	15.2	60	175	0.0835	14.61	0	0.00	0.90	296.9	0.0	0.0	15.6	1.3	0	0.00	2.21	1.0	0.5	1.11	15.72	48.95	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	31.27	31.27	24	17.9	5.7	84	41	0.0063	0.26	0	0.00	0.13	284.0	0.0	0.0	15.2	1.3	60	2.01	3.40	1.0	0.5	1.70	1.95	33.23	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	29.02	29.02	24	27.6	8.8	13	124	0.0148	1.84	0	0.00	0.30	101.9	16.0	14.3	5.7	0.2	84	0.34	0.82	1.0	0.5	0.41	2.25	31.27	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	28.10	28.10	24	34.8	11.1	78	8	0.0236	0.19	0	0.00	0.48	241.9	0.0	0.0	8.8	0.4	13	0.23	1.12	1.3	0.5	0.73	0.92	29.02	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	21.00	21.00	24	34.6	11.0	0	252	0.0234	5.91	0	0.00	0.47	384.5	0.0	0.0	11.1	0.7	78	1.25	2.39	1.0	0.5	1.20	7.10	28.10	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	15.93	15.93	24	32.4	10.3	25	221	0.0205	4.53	0	0.00	0.41	381.9	0.0	0.0	11.0	0.7	0	0.00	1.07	1.0	0.5	0.54	5.07	21.00	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**13.34**	**13.34**	**24**	**31.2**	**9.9**	**0**	**98**	**0.0190**	**1.87**	**0**	**0.00**	**0.38**	**333.9**	**0.0**	**0.0**	**10.3**	**0.6**	**25**	**0.50**	**1.46**	**1.0**	**0.5**	**0.73**	**2.59**	**15.93**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	75.54	75.54	4	1.5	17.0	0	16	0.5190	8.30	0	0.00	1.12	0.0	0.0	0.0	0.0	0.0	0	0.00	1.12	1.0	0.5	0.56	8.87	84.41	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	75.54	75.54	8	0.4	1.1	90	33	0.0008	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	75.57	6.45	HGL Too High!
P3	DI14	DI13	1.00	75.54	75.54	15	0.7	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	75.55	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	73.42	73.42	15	3.3	2.7	0	15	0.0026	0.04	0	0.00	0.03	0.4	25.3	0.4	17.0	1.6	0	0.00	1.60	1.3	1.0	2.08	2.12	75.54	6.58	HGL Too High!
P2	DI2	DI1	1.00	73.22	73.22	15	0.8	0.6	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	73.23	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	50	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	73.21	73.21	15	1.2	1.0	111	3.34	0.0003	0.00	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	70	0.00	0.01	1.3	1.0	0.01	0.01	73.22	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	76.10	76.10	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	76.12	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	76.10	76.10	12	4.9	6.3	90	87	0.0164	1.43	0	0.00	0.15	0.0	0.0	0.0	0.0	0.0	0	0.00	0.15	1.0	1.0	0.15	1.58	77.68	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	71.57	71.57	10	5.1	9.4	90	87	0.0464	4.04	0	0.00	0.34	31.1	0.2	0.0	6.3	0.2	90	0.43	0.99	1.0	0.5	0.49	4.53	76.10	8.13	HGL Too High!
P42	DI31	MH22	1.00	59.21	59.21	15	2.1	1.7	7.5	55.8	0.0009	0.05	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.06	59.28	5.12	HGL Too High!
P43	MH22	DI32	1.00	59.16	59.16	15	2.1	1.7	80	45.1	0.0009	0.04	0	0.00	0.01	3.7	0.0	0.0	1.7	0.0	7.5	0.00	0.03	1.0	0.5	0.02	0.06	59.21	5.45	HGL Too High!
P44	DI32	EX	1.00	58.15	58.15	15	7.5	6.1	90	59.3	0.0115	0.68	0	0.00	0.15	3.7	7.5	0.0	2.5	0.0	94	0.07	0.25	1.3	1.0	0.32	1.00	59.16	5.23	HGL Too High!
P46	DI34	DI33	1.00	59.28	59.28	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	59.28	5.47	HGL Too High!
P45	DI33	DI32	1.00	59.16	59.16	15	3.0	2.5	94	48.5	0.0019	0.09	0	0.00	0.02	0.1	0.0	0.0	0.3	0.0	19	0.00	0.02	1.3	1.0	0.03	0.12	59.28	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	33.23	33.23	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	33.23	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	72.02	72.02	12	2.2	2.9	0	47	0.0034	0.16	0	0.00	0.03	0.0	0.0	0.0	0.0	0.0	0	0.00	0.03	1.0	1.0	0.03	0.19	72.21	3.63	HGL Too High!
P48	DI40	DI41	0.80	72.02	72.02	12	0.6	0.8	90	82.1	0.0002	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	72.04	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	71.57	71.57	12	3.3	4.2	95	41	0.0073	0.30	0	0.00	0.07	0.5	6.4	0.0	2.9	0.0	0	0.00	0.11	1.3	1.0	0.15	0.44	72.02	4.62	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 100 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
MARKET ST RIVER WEST OUTFALL																										
SOUTH SECTION TO 24"																										
P4	DI15	MH1	3244	1216	4460	0.10	0.93	0.09	0.09	6.0	0.00	7.73	0.7	15	27.3	0.012	0.000109	0.005	4.1	5.0	2.9	0.16	6.16	4.49	4.35	Q ok
P5	MH1	MH2	1	0	1	0.00	1.00	0.00	0.19	6.0	6.16	7.66	1.5	18	82.7	0.012	0.000171	0.005	4.5	8.0	3.4	0.41	6.56	4.25	3.84	Q ok
P7	MH2	MH3	1	0	1	0.00	1.00	0.00	0.29	6.0	6.56	7.53	2.2	18	73.8	0.012	0.000377	0.005	4.6	8.1	3.7	0.33	6.89	3.81	3.44	Q ok
P10	MH3	MH4	1	0	1	0.00	1.00	0.00	0.54	6.0	6.89	7.43	4.0	18	53.7	0.012	0.001237	0.005	4.6	8.1	4.5	0.20	7.09	3.34	3.07	Q ok
P13	MH4	MH5	1	0	1	0.00	1.00	0.00	0.93	6.0	7.09	7.36	6.9	18	59.3	0.012	0.003641	0.005	4.3	7.7	5.0	0.20	7.29	2.97	2.70	Q ok
P15	MH5	MH20	1	0	1	0.00	1.00	0.00	1.41	6.0	7.29	7.30	10.3	24	104.1	0.012	0.001769	0.020	11.1	34.8	9.4	0.18	7.48	2.60	0.50	Q ok
P6	DI16	MH2	3400	1275	4675	0.11	0.93	0.10	0.10	6.0	0.00	7.73	0.8	15	29.3	0.012	0.000120	0.005	4.1	5.0	2.9	0.17	6.17	4.06	3.91	Q ok
P9	DI3	MH3	4110	3259	7369	0.17	0.76	0.13	0.13	6.0	0.00	7.73	1.0	15	18.3	0.012	0.000203	0.005	4.0	4.9	3.0	0.10	6.10	3.68	3.59	Q ok
P8	DI17	MH3	3878	2100	5978	0.14	0.85	0.12	0.12	6.0	0.00	7.73	0.9	15	31.3	0.012	0.000166	0.005	4.2	5.2	2.9	0.18	6.18	3.71	3.54	Q ok
P12	DI4	MH4	7109	2561	9670	0.22	0.93	0.21	0.21	6.0	0.00	6.73	1.4	15	20.1	0.012	0.000396	0.005	4.0	4.9	3.4	0.10	6.10	3.48	3.38	Q ok
P11	DI18	MH4	6435	2210	8645	0.20	0.94	0.19	0.19	6.0	0.00	6.70	1.3	15	28.4	0.012	0.000320	0.005	4.1	5.1	3.4	0.14	6.14	3.48	3.33	Q ok
P14	DI5	MH5	4974	2549	7523	0.17	0.86	0.15	0.15	6.0	0.00	7.73	1.1	15	22.6	0.012	0.000270	0.005	4.0	4.9	3.3	0.11	6.11	3.68	3.57	Q ok
P18	DI6	MH6	6937	1863	8800	0.20	0.98	0.20	0.20	6.0	0.00	7.73	1.5	15	38.0	0.012	0.000482	0.005	4.0	4.9	3.4	0.18	6.18	4.57	4.38	Q ok
P16	MH6	MH5	1	0	1	0.00	1.00	0.00	0.33	6.0	6.18	7.66	2.5	18	40.0	0.012	0.000498	0.011	6.8	12.1	5.1	0.13	6.32	3.77	3.32	Q ok
P17	DI19	MH6	4542	1703	6245	0.14	0.93	0.13	0.13	6.0	0.00	7.73	1.0	15	33.0	0.012	0.000214	0.005	4.0	4.9	3.0	0.18	6.18	4.19	4.02	Q ok
NORTH SECTION TO 24"																										
P32	DI23	MH12	5495	1914	7409	0.17	0.94	0.16	0.16	6.0	0.00	7.73	1.2	15	33.31	0.012	0.0003	0.005	4.1	5.0	3.3	0.17	6.17	3.98	3.81	Q ok
P31	DI9	MH12	4483	551	5034	0.12	1.00	0.12	0.12	6.0	0.00	7.73	0.9	15	18.3	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.86	3.77	Q ok
P30	MH12	MH11	1	0	1	0.00	1.00	0.00	0.28	6.0	6.17	7.66	2.1	18	50.1	0.012	0.0003	0.005	4.5	8.0	3.7	0.22	6.39	3.67	3.42	Q ok
P27	MH11	MH10	1	0	1	0.00	1.00	0.00	0.57	6.0	6.39	7.60	4.3	18	73.2	0.012	0.0014	0.005	4.6	8.1	4.7	0.26	6.65	3.39	3.02	Q ok
P25	MH10	MH9	1	0	1	0.00	1.00	0.00	0.65	6.0	6.65	7.50	4.9	24	69.68	0.012	0.0004	0.006	6.3	19.7	5.1	0.23	6.88	2.92	2.47	Q ok
P22	MH9	MH8	1	0	1	0.00	1.00	0.00	0.83	6.0	6.88	7.43	6.1	24	108.3	0.012	0.0006	0.005	5.5	17.3	5.0	0.36	7.24	2.47	1.93	Q ok
P20	MH8	MH21	1	0	1	0.00	1.00	0.00	1.05	6.0	7.24	7.33	7.7	24	57.3	0.012	0.0010	0.021	11.4	35.8	8.5	0.11	7.35	1.65	0.43	Q ok
P21	MH21	EXMH1	1	0	1	0.00	1.00	0.00	1.05	6.0	7.35	7.26	7.7	24	11.3	0.012	0.0010	0.005	5.7	17.9	5.5	0.03	7.39	0.33	0.27	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 100 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P47	DI35	EXMH1	29988	0	29988	0.69	1.00	0.69	0.69	6.0	0.00	7.73	5.3	18	7.75	0.012	0.0022	0.008	5.8	10.3	5.7	0.02	6.02	-0.50	-0.56	Q ok
P-80	DI-80	MH-08	9967	0	9967	0.23	1.00	0.23	0.23	6.0	0.00	7.73	1.8	15	49	0.012	0.0006	0.009	5.5	6.8	4.5	0.18	6.18	4.53	4.07	Q ok
P52	TDI50	DI22	8815	0	8815	0.20	1.00	0.20	0.20	6.0	0.00	7.73	1.6	8	17	0.012	0.0143	0.010	3.8	1.3	3.1	0.09	6.09	3.92	3.75	Undersized!
P51	STUB	DI22	21322	0	21322	0.49	1.00	0.49	0.49	6.0	0.00	7.73	3.8	15	10.02	0.012	0.0029	0.005	4.0	4.9	4.5	0.04	6.04	3.79	3.74	Q ok
P28	DI22	MH11	5555	1955	7510	0.17	0.94	0.16	0.16	6.0	0.00	7.73	1.2	15	30.3	0.012	0.0003	0.005	4.0	4.9	3.3	0.15	6.15	3.64	3.49	Q ok
P29	DI8	MH11	5120	570	5690	0.13	1.00	0.13	0.13	6.0	0.00	7.73	1.0	15	18.3	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.64	3.55	Q ok
P26	DI21	MH10	2755	930	3685	0.08	0.94	0.08	0.08	6.0	0.00	7.73	0.6	15	18.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.11	6.11	4.02	3.93	Q ok
P23	DI20	MH9	3213	1102	4315	0.10	0.94	0.09	0.09	6.0	0.00	7.73	0.7	15	29.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.17	6.17	4.53	4.38	Q ok
P24	DI7	MH9	3164	527	3691	0.08	1.00	0.08	0.08	6.0	0.00	7.73	0.7	15	28.02	0.012	0.0001	0.005	4.0	4.9	2.8	0.17	6.17	4.38	4.24	Q ok
SOUTH SECTION LOW TRUNK TO 24" OUTFALL																										
CRB-P72	CRB-DI72	CRB-MH-74	6086	0	6086	0.14	1.00	0.14	0.14	6.0	0.00	7.73	1.1	15	16	0.012	0.0002	0.019	7.8	9.6	4.7	0.06	6.06	2.60	2.30	Q ok
CRB-P73	CRB-DI73	CRB-MH-74	7042	0	7042	0.16	1.00	0.16	0.16	6.0	0.00	7.73	1.2	15	34	0.012	0.0003	0.005	4.0	4.9	3.3	0.17	6.17	1.92	1.75	Q ok
CRB-P74	CRB-MH-74	CRB-MH-67	1	0	1	0.00	1.00	0.00	0.30	6.0	6.17	7.66	2.3	15	154	0.012	0.0011	0.005	4.1	5.1	4.0	0.64	6.81	1.65	0.84	Q ok
EXP2	CRB-MH-67	EXMH3	1	0	1	0.00	1.00	0.00	0.76	6.0	6.81	7.46	5.6	15	23	0.013	0.0076	***0.003***	***2.7***	3.3	2.2	0.17	6.99	-1.14	-1.20	Undersized!
EXP3	EXMH3	EXMH4	1	0	1	0.00	1.00	0.00	0.94	6.0	6.99	7.40	6.9	15	78	0.013	0.0115	***0.003***	***2.7***	3.3	2.2	0.59	7.58	-1.20	-1.40	Undersized!
EXP4	EXMH4	EXMH5	1	0	1	0.00	1.00	0.00	0.94	6.0	7.58	7.20	6.7	15	54	0.013	0.0109	***0.003***	***2.7***	3.3	2.2	0.41	7.99	-1.40	-1.54	Undersized!
EXP5	EXMH5	EXMH6	1	0	1	0.00	1.00	0.00	2.14	6.0	7.99	7.06	15.1	15	263	0.013	0.0549	***0.003***	***2.7***	3.3	2.2	2.00	9.99	-1.54	-2.22	Undersized!
EXP6	EXMH6	EXMH7	1	0	1	0.00	1.00	0.00	3.19	6.0	9.99	6.40	20.4	15	96	0.013	0.0999	***0.003***	***2.7***	3.3	2.2	0.73	10.71	-2.22	-2.47	Undersized!
EXP7	EXMH7	EXMH8	1	0	1	0.00	1.00	0.00	3.19	6.0	10.71	6.26	20.0	15	175	0.013	0.0956	***0.003***	***2.7***	3.3	2.2	1.33	12.04	-2.47	-2.92	Undersized!
EXP8	EXMH8	EXMH9	1	0	1	0.00	1.00	0.00	3.19	6.0	12.04	6.00	19.1	24	41	0.013	0.0072	0.009	6.8	21.4	7.8	0.09	12.13	-2.92	-3.29	Q ok
EXP9	EXMH9	EXMH10	1	0	1	0.00	1.00	0.00	4.93	6.0	12.13	5.98	29.5	24	124	0.013	0.0170	0.009	6.8	21.4	5.6	0.37	12.50	-3.29	-4.40	Undersized!
EXP10	EXMH10	EXMH11	1	0	1	0.00	1.00	0.00	6.35	6.0	12.50	5.90	37.4	24	8	0.013	0.0274	***0.001***	***2.7***	8.5	2.2	0.06	12.56	-4.40	-4.41	Undersized!
EXP11	EXMH11	EXMH12	1	0	1	0.00	1.00	0.00	6.35	6.0	12.56	5.88	37.3	24	252	0.013	0.0272	***0.001***	***2.7***	8.5	2.2	1.90	14.46	-4.41	-4.76	Undersized!
EXP12	EXMH12	EXMH13	1	0	1	0.00	1.00	0.00	6.35	6.0	14.46	5.50	34.9	24	221	0.013	0.0238	***0.001***	***2.7***	8.5	2.2	1.67	16.13	-4.76	-5.07	Undersized!
EXP13	**EXMH13**	**OUTFALL**	**1**	**0**	**1**	**0.00**	1.00	**0.00**	**6.35**	**6.0**	**16.13**	5.31	33.7	**24**	**98**	**0.013**	**0.0222**	***0.001***	***2.7***	**8.5**	**2.2**	**0.74**	**16.87**	**-5.07**	**-5.21**	**Undersized!**
ROOF	COLLINS	MSS DI-13	8875	0	8875	0.20	1.00	0.20	0.20	6.0	0.00	7.73	1.6	4	16	0.012	0.5832	0.019	3.2	0.3	2.7	0.10	6.10	2.60	2.30	Undersized!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 100 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
CRB-P75	TD-03	MSS DI-13	2341	0	2341	0.05	1.00	0.05	0.05	6.0	0.00	7.73	**0.42**	8	33	0.011	0.000846	0.0348	7.6	**2.7**	5.3	0.10	6.10	4.57	3.42	Q ok
P3	DI14	DI13	3876	441	4317	0.10	1.00	0.10	0.10	6.0	0.00	7.73	0.8	15	69.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.41	6.41	4.03	3.68	Q ok
EXP1	DI13	MH67	3876	441	4317	0.10	1.00	0.10	0.46	6.0	6.41	7.60	3.5	15	15	0.013	0.0029	***0.003***	***2.7***	3.3	2.2	0.11	6.52	-1.10	-1.14	Undersized!
P2	DI2	DI1	3846	1139	4985	0.11	0.97	0.11	0.11	6.0	0.00	7.73	0.9	15	69.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.41	6.41	4.03	3.68	Q ok
P1	DI1	EXMH	2301	1082	3383	0.08	0.88	0.07	0.18	6.0	6.41	7.60	1.4	15	3.34	0.012	0.0004	0.005	4.0	4.9	3.3	0.02	6.43	3.39	3.37	Q ok
CRB-P84	TD-04	EXMH	1667	0	1667	0.04	1.00	0.04	0.04	6.0	0.00	7.73	**0.30**	8	46	0.011	0.000429	0.0383	8.0	**2.8**	4.8	0.16	6.16	6.26	4.50	Q ok
EXP15	EXDI	EXMH	24757	6130	30887	0.71	1.00	0.71	0.71	6.0	0.00	7.73	**5.46**	12	87	0.012	0.020014	0.0049	3.5	**2.7**	2.8	0.51	6.51	2.00	1.57	Undersized!
EXP16	EXMH	EXMH5	1	0	1	0.00	1.00	0.00	0.74	6.0	6.51	7.56	**5.63**	10	87	0.012	0.056314	0.0049	3.1	**1.7**	2.5	0.58	7.09	2.00	1.57	Undersized!
P42	DI31	MH22	12796.5	0	12797	0.29	1.00	0.29	0.29	6.0	0.00	7.73	2.3	15	55.8	0.012	0.0011	0.005	4.0	5.0	3.9	0.24	6.24	2.00	1.72	Q ok
P43	MH22	DI32	1	0	1	0.00	1.00	0.00	0.29	6.0	6.24	7.66	2.3	15	45.1	0.012	0.0010	0.005	4.1	5.0	4.0	0.19	6.43	1.62	1.39	Q ok
P44	DI32	EX	14459.5	0	14460	0.33	1.00	0.33	1.05	6.0	6.43	7.60	8.0	15	59.3	0.012	0.0129	0.030	9.9	12.1	10.6	0.09	6.52	1.29	0.70	Q ok
P46	DI34	DI33	2420	0	2420	0.06	1.00	0.06	0.06	6.0	0.00	7.73	0.4	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.4	0.26	6.26	2.00	1.82	Q ok
P45	DI33	DI32	15975	0	15975	0.37	1.00	0.37	0.42	6.0	6.26	7.63	3.2	15	48.5	0.012	0.0021	0.007	4.7	5.8	4.8	0.17	6.43	1.72	1.39	Q ok
EXP17	EXMH	EXMH8	1	0	1	0.00	1.00	0.00	0.00	6.0	0.00	7.73	0.0	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.0	0.32	6.32	2.00	1.82	Q ok
EX-P LOT	EXDI LOT	DI-MSS-41	13430	0	13430	0.31	1.00	0.31	0.31	6.0	0.00	7.73	**2.38**	12	47	0.012	0.003811	0.0074	4.2	**3.3**	4.6	0.17	6.17	2.50	2.15	Q ok
P48	DI40	DI41	3590	0	3590	0.08	1.00	0.08	0.08	6.0	0.00	7.73	0.6	12	82.1	0.012	0.0003	0.005	3.5	2.7	2.8	0.48	6.48	2.56	2.15	Q ok
P-MSS-48A	DI-MSS-41	EX-MH LOW	3072	0	3072	0.07	1.00	0.07	0.46	6.0	6.48	7.56	**3.49**	12	41	0.012	0.008166	0.0051	3.5	**2.8**	2.9	0.24	6.72	2.05	1.84	Undersized!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	22.13	22.13	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.13	7.41	
P5	MH1	MH2	1.20	22.11	22.11	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	22.13	7.93	HGL Too High!
P7	MH2	MH3	1.20	22.07	22.07	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	22.11	7.65	HGL Too High!
P10	MH3	MH4	1.20	21.99	21.99	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	22.07	7.28	HGL Too High!
P13	MH4	MH5	1.20	21.73	21.73	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	21.99	7.09	HGL Too High!
P15	MH5	MH20	1.60	21.40	21.40	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	21.73	7.40	HGL Too High!
P6	DI16	MH2	1.00	22.11	22.11	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.11	7.33	HGL Too High!
P9	DI3	MH3	1.00	22.07	22.07	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.08	6.62	HGL Too High!
P8	DI17	MH3	1.00	22.07	22.07	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.08	6.96	HGL Too High!
P12	DI4	MH4	1.00	21.99	21.99	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	22.01	6.48	HGL Too High!
P11	DI18	MH4	1.00	21.99	21.99	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.01	6.56	HGL Too High!
P14	DI5	MH5	1.00	21.73	21.73	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.74	6.61	HGL Too High!
P18	DI6	MH6	1.00	21.76	21.76	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	21.79	7.13	HGL Too High!
P16	MH6	MH5	1.20	21.73	21.73	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	21.76	7.55	HGL Too High!
P17	DI19	MH6	1.00	21.76	21.76	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.77	7.08	HGL Too High!
P32	DI23	MH12	1.00	24.40	24.40	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.42	4.24	HGL Too High!
P31	DI9	MH12	1.00	24.40	24.40	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.41	7.13	HGL Too High!
P30	MH12	MH11	1.60	24.38	24.38	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	24.40	7.48	HGL Too High!
P27	MH11	MH10	1.60	24.27	24.27	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	24.38	7.21	HGL Too High!
P25	MH10	MH9	1.60	24.23	24.23	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	24.27	7.54	HGL Too High!
P22	MH9	MH8	1.60	24.15	24.15	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	24.23	7.85	HGL Too High!
P20	MH8	MH21	1.60	24.05	24.05	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	24.15	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	23.98	23.98	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	24.05	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	23.98	23.98	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	24.03	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	24.15	24.15	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	24.18	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	24.44	24.44	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	24.76	4.78	HGL Too High!
P51	STUB	DI22	1.00	24.44	24.44	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	24.49	7.16	HGL Too High!
P28	DI22	MH11	1.00	24.38	24.38	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	24.44	6.74	HGL Too High!
P29	DI8	MH11	1.00	24.38	24.38	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.38	6.92	HGL Too High!
P26	DI21	MH10	1.00	24.27	24.27	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.27	7.23	HGL Too High!
P23	DI20	MH9	1.00	24.23	24.23	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	24.23	7.38	HGL Too High!
P24	DI7	MH9	1.00	24.23	24.23	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.23	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	72.64	72.64	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	72.64	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	72.64	72.64	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	72.65	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	72.45	72.45	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	72.64	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	72.21	72.21	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	72.45	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	71.08	71.08	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	72.21	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	70.35	70.35	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	71.08	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	54.75	54.75	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	70.35	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	44.21	44.21	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	54.75	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	26.22	26.22	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	44.21	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	23.98	23.98	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	26.22	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	21.40	21.40	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	23.98	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	20.35	20.35	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	21.40	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.10	12.10	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	20.35	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	6.22	6.22	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	12.10	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.20**	**3.20**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**6.22**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	74.84	74.84	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	84.80	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	74.84	74.84	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	74.87	6.45	HGL Too High!
P3	DI14	DI13	1.00	74.84	74.84	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	74.85	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	72.45	72.45	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	74.84	6.58	HGL Too High!
P2	DI2	DI1	1.00	72.23	72.23	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	72.24	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	72.21	72.21	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	72.23	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	75.85	75.85	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	75.87	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	75.85	75.85	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	77.78	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	70.35	70.35	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	75.85	8.13	HGL Too High!
P42	DI31	MH22	1.00	55.94	55.94	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	56.02	5.12	HGL Too High!
P43	MH22	DI32	1.00	55.88	55.88	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	55.94	5.45	HGL Too High!
P44	DI32	EX	1.00	54.75	54.75	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	55.88	5.23	HGL Too High!
P46	DI34	DI33	1.00	56.02	56.02	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	56.02	5.47	HGL Too High!
P45	DI33	DI32	1.00	55.88	55.88	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	56.02	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	26.22	26.22	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	26.22	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	70.85	70.85	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	71.07	3.63	HGL Too High!
P48	DI40	DI41	0.80	70.85	70.85	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	70.88	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	70.35	70.35	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	70.85	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	22.33	22.33	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	22.33	7.41	
P5	MH1	MH2	1.20	22.31	22.31	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	22.33	7.93	HGL Too High!
P7	MH2	MH3	1.20	22.27	22.27	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	22.31	7.65	HGL Too High!
P10	MH3	MH4	1.20	22.19	22.19	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	22.27	7.28	HGL Too High!
P13	MH4	MH5	1.20	21.93	21.93	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	22.19	7.09	HGL Too High!
P15	MH5	MH20	1.60	21.60	21.60	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	21.93	7.40	HGL Too High!
P6	DI16	MH2	1.00	22.31	22.31	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.31	7.33	HGL Too High!
P9	DI3	MH3	1.00	22.27	22.27	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.28	6.62	HGL Too High!
P8	DI17	MH3	1.00	22.27	22.27	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.28	6.96	HGL Too High!
P12	DI4	MH4	1.00	22.19	22.19	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	22.21	6.48	HGL Too High!
P11	DI18	MH4	1.00	22.19	22.19	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	22.21	6.56	HGL Too High!
P14	DI5	MH5	1.00	21.93	21.93	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.94	6.61	HGL Too High!
P18	DI6	MH6	1.00	21.96	21.96	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	21.99	7.13	HGL Too High!
P16	MH6	MH5	1.20	21.93	21.93	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	21.96	7.55	HGL Too High!
P17	DI19	MH6	1.00	21.96	21.96	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	21.97	7.08	HGL Too High!
P32	DI23	MH12	1.00	24.60	24.60	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.62	4.24	HGL Too High!
P31	DI9	MH12	1.00	24.60	24.60	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.61	7.13	HGL Too High!
P30	MH12	MH11	1.60	24.58	24.58	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	24.60	7.48	HGL Too High!
P27	MH11	MH10	1.60	24.47	24.47	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	24.58	7.21	HGL Too High!
P25	MH10	MH9	1.60	24.43	24.43	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	24.47	7.54	HGL Too High!
P22	MH9	MH8	1.60	24.35	24.35	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	24.43	7.85	HGL Too High!
P20	MH8	MH21	1.60	24.25	24.25	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	24.35	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	24.18	24.18	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	24.25	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	24.18	24.18	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	24.23	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	24.35	24.35	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	24.38	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	24.64	24.64	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	24.96	4.78	HGL Too High!
P51	STUB	DI22	1.00	24.64	24.64	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	24.69	7.16	HGL Too High!
P28	DI22	MH11	1.00	24.58	24.58	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	24.64	6.74	HGL Too High!
P29	DI8	MH11	1.00	24.58	24.58	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.58	6.92	HGL Too High!
P26	DI21	MH10	1.00	24.47	24.47	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.47	7.23	HGL Too High!
P23	DI20	MH9	1.00	24.43	24.43	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	24.43	7.38	HGL Too High!
P24	DI7	MH9	1.00	24.43	24.43	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.43	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	72.84	72.84	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	72.84	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	72.84	72.84	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	72.85	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	72.65	72.65	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	72.84	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	72.41	72.41	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	72.65	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	71.28	71.28	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	72.41	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	70.55	70.55	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	71.28	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	54.95	54.95	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	70.55	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	44.41	44.41	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	54.95	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	26.42	26.42	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	44.41	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	24.18	24.18	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	26.42	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	21.60	21.60	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	24.18	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	20.55	20.55	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	21.60	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.30	12.30	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	20.55	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	6.42	6.42	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	12.30	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.40**	**3.40**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**6.42**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	75.04	75.04	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	85.00	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	75.04	75.04	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	75.07	6.45	HGL Too High!
P3	DI14	DI13	1.00	75.04	75.04	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	75.05	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	72.65	72.65	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	75.04	6.58	HGL Too High!
P2	DI2	DI1	1.00	72.43	72.43	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	72.44	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	72.41	72.41	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	72.43	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	76.05	76.05	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	76.07	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	76.05	76.05	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	77.98	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	70.55	70.55	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	76.05	8.13	HGL Too High!
P42	DI31	MH22	1.00	56.14	56.14	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	56.22	5.12	HGL Too High!
P43	MH22	DI32	1.00	56.08	56.08	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	56.14	5.45	HGL Too High!
P44	DI32	EX	1.00	54.95	54.95	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	56.08	5.23	HGL Too High!
P46	DI34	DI33	1.00	56.22	56.22	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	56.22	5.47	HGL Too High!
P45	DI33	DI32	1.00	56.08	56.08	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	56.22	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	26.42	26.42	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	26.42	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	71.05	71.05	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	71.27	3.63	HGL Too High!
P48	DI40	DI41	0.80	71.05	71.05	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	71.08	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	70.55	70.55	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	71.05	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	25.83	25.83	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	25.83	7.41	
P5	MH1	MH2	1.20	25.81	25.81	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	25.83	7.93	HGL Too High!
P7	MH2	MH3	1.20	25.77	25.77	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	25.81	7.65	HGL Too High!
P10	MH3	MH4	1.20	25.69	25.69	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	25.77	7.28	HGL Too High!
P13	MH4	MH5	1.20	25.43	25.43	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	25.69	7.09	HGL Too High!
P15	MH5	MH20	1.60	25.10	25.10	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	25.43	7.40	HGL Too High!
P6	DI16	MH2	1.00	25.81	25.81	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.81	7.33	HGL Too High!
P9	DI3	MH3	1.00	25.77	25.77	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.78	6.62	HGL Too High!
P8	DI17	MH3	1.00	25.77	25.77	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.78	6.96	HGL Too High!
P12	DI4	MH4	1.00	25.69	25.69	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	25.71	6.48	HGL Too High!
P11	DI18	MH4	1.00	25.69	25.69	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.71	6.56	HGL Too High!
P14	DI5	MH5	1.00	25.43	25.43	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.44	6.61	HGL Too High!
P18	DI6	MH6	1.00	25.46	25.46	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	25.49	7.13	HGL Too High!
P16	MH6	MH5	1.20	25.43	25.43	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	25.46	7.55	HGL Too High!
P17	DI19	MH6	1.00	25.46	25.46	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.47	7.08	HGL Too High!
P32	DI23	MH12	1.00	28.10	28.10	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.12	4.24	HGL Too High!
P31	DI9	MH12	1.00	28.10	28.10	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.11	7.13	HGL Too High!
P30	MH12	MH11	1.60	28.08	28.08	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	28.10	7.48	HGL Too High!
P27	MH11	MH10	1.60	27.97	27.97	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	28.08	7.21	HGL Too High!
P25	MH10	MH9	1.60	27.93	27.93	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	27.97	7.54	HGL Too High!
P22	MH9	MH8	1.60	27.85	27.85	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	27.93	7.85	HGL Too High!
P20	MH8	MH21	1.60	27.75	27.75	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	27.85	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	27.68	27.68	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	27.75	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	27.68	27.68	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	27.73	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	27.85	27.85	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	27.88	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	28.14	28.14	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	28.46	4.78	HGL Too High!
P51	STUB	DI22	1.00	28.14	28.14	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	28.19	7.16	HGL Too High!
P28	DI22	MH11	1.00	28.08	28.08	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	28.14	6.74	HGL Too High!
P29	DI8	MH11	1.00	28.08	28.08	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.08	6.92	HGL Too High!
P26	DI21	MH10	1.00	27.97	27.97	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.97	7.23	HGL Too High!
P23	DI20	MH9	1.00	27.93	27.93	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	27.93	7.38	HGL Too High!
P24	DI7	MH9	1.00	27.93	27.93	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.93	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	76.34	76.34	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	76.34	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	76.34	76.34	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	76.35	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	76.15	76.15	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	76.34	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	75.91	75.91	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	76.15	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	74.78	74.78	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	75.91	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	74.05	74.05	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	74.78	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	58.45	58.45	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	74.05	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	47.91	47.91	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	58.45	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	29.92	29.92	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	47.91	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	27.68	27.68	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	29.92	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	25.10	25.10	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	27.68	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	24.05	24.05	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	25.10	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.80	15.80	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	24.05	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.92	9.92	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	15.80	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**6.90**	**6.90**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**9.92**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	78.54	78.54	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	88.50	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	78.54	78.54	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	78.57	6.45	HGL Too High!
P3	DI14	DI13	1.00	78.54	78.54	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.55	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	76.15	76.15	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	78.54	6.58	HGL Too High!
P2	DI2	DI1	1.00	75.93	75.93	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	75.94	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	75.91	75.91	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	75.93	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	79.55	79.55	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	79.57	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	79.55	79.55	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	81.48	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	74.05	74.05	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	79.55	8.13	HGL Too High!
P42	DI31	MH22	1.00	59.64	59.64	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	59.72	5.12	HGL Too High!
P43	MH22	DI32	1.00	59.58	59.58	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	59.64	5.45	HGL Too High!
P44	DI32	EX	1.00	58.45	58.45	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	59.58	5.23	HGL Too High!
P46	DI34	DI33	1.00	59.72	59.72	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	59.72	5.47	HGL Too High!
P45	DI33	DI32	1.00	59.58	59.58	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	59.72	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	29.92	29.92	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	29.92	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	74.55	74.55	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	74.77	3.63	HGL Too High!
P48	DI40	DI41	0.80	74.55	74.55	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	74.58	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	74.05	74.05	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	74.55	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	26.33	26.33	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.33	7.41	
P5	MH1	MH2	1.20	26.31	26.31	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	26.33	7.93	HGL Too High!
P7	MH2	MH3	1.20	26.27	26.27	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	26.31	7.65	HGL Too High!
P10	MH3	MH4	1.20	26.19	26.19	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	26.27	7.28	HGL Too High!
P13	MH4	MH5	1.20	25.93	25.93	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	26.19	7.09	HGL Too High!
P15	MH5	MH20	1.60	25.60	25.60	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	25.93	7.40	HGL Too High!
P6	DI16	MH2	1.00	26.31	26.31	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.31	7.33	HGL Too High!
P9	DI3	MH3	1.00	26.27	26.27	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.28	6.62	HGL Too High!
P8	DI17	MH3	1.00	26.27	26.27	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.28	6.96	HGL Too High!
P12	DI4	MH4	1.00	26.19	26.19	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	26.21	6.48	HGL Too High!
P11	DI18	MH4	1.00	26.19	26.19	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.21	6.56	HGL Too High!
P14	DI5	MH5	1.00	25.93	25.93	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.94	6.61	HGL Too High!
P18	DI6	MH6	1.00	25.96	25.96	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	25.99	7.13	HGL Too High!
P16	MH6	MH5	1.20	25.93	25.93	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	25.96	7.55	HGL Too High!
P17	DI19	MH6	1.00	25.96	25.96	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.97	7.08	HGL Too High!
P32	DI23	MH12	1.00	28.60	28.60	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.62	4.24	HGL Too High!
P31	DI9	MH12	1.00	28.60	28.60	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.61	7.13	HGL Too High!
P30	MH12	MH11	1.60	28.58	28.58	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	28.60	7.48	HGL Too High!
P27	MH11	MH10	1.60	28.47	28.47	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	28.58	7.21	HGL Too High!
P25	MH10	MH9	1.60	28.43	28.43	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	28.47	7.54	HGL Too High!
P22	MH9	MH8	1.60	28.35	28.35	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	28.43	7.85	HGL Too High!
P20	MH8	MH21	1.60	28.25	28.25	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	28.35	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	28.18	28.18	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	28.25	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	28.18	28.18	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	28.23	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	28.35	28.35	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	28.38	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	28.64	28.64	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	28.96	4.78	HGL Too High!
P51	STUB	DI22	1.00	28.64	28.64	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	28.69	7.16	HGL Too High!
P28	DI22	MH11	1.00	28.58	28.58	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	28.64	6.74	HGL Too High!
P29	DI8	MH11	1.00	28.58	28.58	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.58	6.92	HGL Too High!
P26	DI21	MH10	1.00	28.47	28.47	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.47	7.23	HGL Too High!
P23	DI20	MH9	1.00	28.43	28.43	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	28.43	7.38	HGL Too High!
P24	DI7	MH9	1.00	28.43	28.43	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.43	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	76.84	76.84	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	76.84	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	76.84	76.84	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	76.85	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	76.65	76.65	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	76.84	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	76.41	76.41	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	76.65	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	75.28	75.28	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	76.41	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	74.55	74.55	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	75.28	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	58.95	58.95	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	74.55	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	48.41	48.41	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	58.95	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	30.42	30.42	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	48.41	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	28.18	28.18	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	30.42	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	25.60	25.60	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	28.18	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	24.55	24.55	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	25.60	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	16.30	16.30	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	24.55	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.42	10.42	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	16.30	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.40**	**7.40**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**10.42**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	79.04	79.04	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	89.00	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	79.04	79.04	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	79.07	6.45	HGL Too High!
P3	DI14	DI13	1.00	79.04	79.04	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	79.05	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	76.65	76.65	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	79.04	6.58	HGL Too High!
P2	DI2	DI1	1.00	76.43	76.43	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	76.44	6.84	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	76.41	76.41	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	76.43	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	80.05	80.05	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	80.07	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	80.05	80.05	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	81.98	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	74.55	74.55	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	80.05	8.13	HGL Too High!
P42	DI31	MH22	1.00	60.14	60.14	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	60.22	5.12	HGL Too High!
P43	MH22	DI32	1.00	60.08	60.08	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	60.14	5.45	HGL Too High!
P44	DI32	EX	1.00	58.95	58.95	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	60.08	5.23	HGL Too High!
P46	DI34	DI33	1.00	60.22	60.22	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	60.22	5.47	HGL Too High!
P45	DI33	DI32	1.00	60.08	60.08	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	60.22	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	30.42	30.42	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	30.42	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	75.05	75.05	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	75.27	3.63	HGL Too High!
P48	DI40	DI41	0.80	75.05	75.05	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	75.08	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	74.55	74.55	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	75.05	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	26.73	26.73	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.73	7.41	
P5	MH1	MH2	1.20	26.71	26.71	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	26.73	7.93	HGL Too High!
P7	MH2	MH3	1.20	26.67	26.67	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	26.71	7.65	HGL Too High!
P10	MH3	MH4	1.20	26.59	26.59	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	26.67	7.28	HGL Too High!
P13	MH4	MH5	1.20	26.33	26.33	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	26.59	7.09	HGL Too High!
P15	MH5	MH20	1.60	26.00	26.00	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	26.33	7.40	HGL Too High!
P6	DI16	MH2	1.00	26.71	26.71	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.71	7.33	HGL Too High!
P9	DI3	MH3	1.00	26.67	26.67	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.68	6.62	HGL Too High!
P8	DI17	MH3	1.00	26.67	26.67	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.68	6.96	HGL Too High!
P12	DI4	MH4	1.00	26.59	26.59	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	26.61	6.48	HGL Too High!
P11	DI18	MH4	1.00	26.59	26.59	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.61	6.56	HGL Too High!
P14	DI5	MH5	1.00	26.33	26.33	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.34	6.61	HGL Too High!
P18	DI6	MH6	1.00	26.36	26.36	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	26.39	7.13	HGL Too High!
P16	MH6	MH5	1.20	26.33	26.33	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	26.36	7.55	HGL Too High!
P17	DI19	MH6	1.00	26.36	26.36	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.37	7.08	HGL Too High!
P32	DI23	MH12	1.00	29.00	29.00	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.02	4.24	HGL Too High!
P31	DI9	MH12	1.00	29.00	29.00	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.01	7.13	HGL Too High!
P30	MH12	MH11	1.60	28.98	28.98	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	29.00	7.48	HGL Too High!
P27	MH11	MH10	1.60	28.87	28.87	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	28.98	7.21	HGL Too High!
P25	MH10	MH9	1.60	28.83	28.83	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	28.87	7.54	HGL Too High!
P22	MH9	MH8	1.60	28.75	28.75	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	28.83	7.85	HGL Too High!
P20	MH8	MH21	1.60	28.65	28.65	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	28.75	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	28.58	28.58	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	28.65	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	28.58	28.58	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	28.63	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	28.75	28.75	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	28.78	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	29.04	29.04	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	29.36	4.78	HGL Too High!
P51	STUB	DI22	1.00	29.04	29.04	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	29.09	7.16	HGL Too High!
P28	DI22	MH11	1.00	28.98	28.98	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	29.04	6.74	HGL Too High!
P29	DI8	MH11	1.00	28.98	28.98	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.98	6.92	HGL Too High!
P26	DI21	MH10	1.00	28.87	28.87	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.87	7.23	HGL Too High!
P23	DI20	MH9	1.00	28.83	28.83	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	28.83	7.38	HGL Too High!
P24	DI7	MH9	1.00	28.83	28.83	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.83	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	77.24	77.24	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	77.24	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	77.24	77.24	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	77.25	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	77.05	77.05	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	77.24	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	76.81	76.81	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	77.05	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	75.68	75.68	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	76.81	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	74.95	74.95	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	75.68	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	59.35	59.35	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	74.95	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	48.81	48.81	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	59.35	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	30.82	30.82	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	48.81	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	28.58	28.58	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	30.82	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	26.00	26.00	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	28.58	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	24.95	24.95	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	26.00	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	16.70	16.70	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	24.95	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.82	10.82	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	16.70	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.80**	**7.80**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**10.82**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	79.44	79.44	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	89.40	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	79.44	79.44	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	79.47	6.45	HGL Too High!
P3	DI14	DI13	1.00	79.44	79.44	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	79.45	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	77.05	77.05	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	79.44	6.58	HGL Too High!
P2	DI2	DI1	1.00	76.83	76.83	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	76.84	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	76.81	76.81	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	76.83	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	80.45	80.45	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	80.47	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	80.45	80.45	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	82.38	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	74.95	74.95	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	80.45	8.13	HGL Too High!
P42	DI31	MH22	1.00	60.54	60.54	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	60.62	5.12	HGL Too High!
P43	MH22	DI32	1.00	60.48	60.48	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	60.54	5.45	HGL Too High!
P44	DI32	EX	1.00	59.35	59.35	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	60.48	5.23	HGL Too High!
P46	DI34	DI33	1.00	60.62	60.62	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	60.62	5.47	HGL Too High!
P45	DI33	DI32	1.00	60.48	60.48	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	60.62	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	30.82	30.82	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	30.82	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	75.45	75.45	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	75.67	3.63	HGL Too High!
P48	DI40	DI41	0.80	75.45	75.45	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	75.48	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	74.95	74.95	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	75.45	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	27.23	27.23	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.23	7.41	
P5	MH1	MH2	1.20	27.21	27.21	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	27.23	7.93	HGL Too High!
P7	MH2	MH3	1.20	27.17	27.17	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	27.21	7.65	HGL Too High!
P10	MH3	MH4	1.20	27.09	27.09	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	27.17	7.28	HGL Too High!
P13	MH4	MH5	1.20	26.83	26.83	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	27.09	7.09	HGL Too High!
P15	MH5	MH20	1.60	26.50	26.50	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	26.83	7.40	HGL Too High!
P6	DI16	MH2	1.00	27.21	27.21	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.21	7.33	HGL Too High!
P9	DI3	MH3	1.00	27.17	27.17	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.18	6.62	HGL Too High!
P8	DI17	MH3	1.00	27.17	27.17	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.18	6.96	HGL Too High!
P12	DI4	MH4	1.00	27.09	27.09	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	27.11	6.48	HGL Too High!
P11	DI18	MH4	1.00	27.09	27.09	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.11	6.56	HGL Too High!
P14	DI5	MH5	1.00	26.83	26.83	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.84	6.61	HGL Too High!
P18	DI6	MH6	1.00	26.86	26.86	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	26.89	7.13	HGL Too High!
P16	MH6	MH5	1.20	26.83	26.83	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	26.86	7.55	HGL Too High!
P17	DI19	MH6	1.00	26.86	26.86	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.87	7.08	HGL Too High!
P32	DI23	MH12	1.00	29.50	29.50	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.52	4.24	HGL Too High!
P31	DI9	MH12	1.00	29.50	29.50	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.51	7.13	HGL Too High!
P30	MH12	MH11	1.60	29.48	29.48	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	29.50	7.48	HGL Too High!
P27	MH11	MH10	1.60	29.37	29.37	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	29.48	7.21	HGL Too High!
P25	MH10	MH9	1.60	29.33	29.33	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	29.37	7.54	HGL Too High!
P22	MH9	MH8	1.60	29.25	29.25	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	29.33	7.85	HGL Too High!
P20	MH8	MH21	1.60	29.15	29.15	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	29.25	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	29.08	29.08	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	29.15	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	29.08	29.08	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	29.13	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	29.25	29.25	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	29.28	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	29.54	29.54	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	29.86	4.78	HGL Too High!
P51	STUB	DI22	1.00	29.54	29.54	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	29.59	7.16	HGL Too High!
P28	DI22	MH11	1.00	29.48	29.48	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	29.54	6.74	HGL Too High!
P29	DI8	MH11	1.00	29.48	29.48	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.48	6.92	HGL Too High!
P26	DI21	MH10	1.00	29.37	29.37	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.37	7.23	HGL Too High!
P23	DI20	MH9	1.00	29.33	29.33	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	29.33	7.38	HGL Too High!
P24	DI7	MH9	1.00	29.33	29.33	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.33	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	77.74	77.74	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	77.74	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	77.74	77.74	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	77.75	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	77.55	77.55	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	77.74	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	77.31	77.31	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	77.55	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	76.18	76.18	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	77.31	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	75.45	75.45	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	76.18	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	59.85	59.85	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	75.45	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	49.31	49.31	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	59.85	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	31.32	31.32	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	49.31	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	29.08	29.08	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	31.32	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	26.50	26.50	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	29.08	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	25.45	25.45	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	26.50	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	17.20	17.20	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	25.45	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.32	11.32	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	17.20	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**8.30**	**8.30**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**11.32**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	79.94	79.94	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	89.90	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	79.94	79.94	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	79.97	6.45	HGL Too High!
P3	DI14	DI13	1.00	79.94	79.94	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	79.95	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	77.55	77.55	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	79.94	6.58	HGL Too High!
P2	DI2	DI1	1.00	77.33	77.33	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	77.34	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	77.31	77.31	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	77.33	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	80.95	80.95	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	80.97	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	80.95	80.95	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	82.88	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	75.45	75.45	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	80.95	8.13	HGL Too High!
P42	DI31	MH22	1.00	61.04	61.04	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	61.12	5.12	HGL Too High!
P43	MH22	DI32	1.00	60.98	60.98	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	61.04	5.45	HGL Too High!
P44	DI32	EX	1.00	59.85	59.85	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	60.98	5.23	HGL Too High!
P46	DI34	DI33	1.00	61.12	61.12	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	61.12	5.47	HGL Too High!
P45	DI33	DI32	1.00	60.98	60.98	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	61.12	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	31.32	31.32	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	31.32	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	75.95	75.95	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	76.17	3.63	HGL Too High!
P48	DI40	DI41	0.80	75.95	75.95	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	75.98	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	75.45	75.45	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	75.95	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	27.93	27.93	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.93	7.41	
P5	MH1	MH2	1.20	27.91	27.91	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	27.93	7.93	HGL Too High!
P7	MH2	MH3	1.20	27.87	27.87	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	27.91	7.65	HGL Too High!
P10	MH3	MH4	1.20	27.79	27.79	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	27.87	7.28	HGL Too High!
P13	MH4	MH5	1.20	27.53	27.53	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	27.79	7.09	HGL Too High!
P15	MH5	MH20	1.60	27.20	27.20	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	27.53	7.40	HGL Too High!
P6	DI16	MH2	1.00	27.91	27.91	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.91	7.33	HGL Too High!
P9	DI3	MH3	1.00	27.87	27.87	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.88	6.62	HGL Too High!
P8	DI17	MH3	1.00	27.87	27.87	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.88	6.96	HGL Too High!
P12	DI4	MH4	1.00	27.79	27.79	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	27.81	6.48	HGL Too High!
P11	DI18	MH4	1.00	27.79	27.79	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.81	6.56	HGL Too High!
P14	DI5	MH5	1.00	27.53	27.53	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.54	6.61	HGL Too High!
P18	DI6	MH6	1.00	27.56	27.56	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	27.59	7.13	HGL Too High!
P16	MH6	MH5	1.20	27.53	27.53	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	27.56	7.55	HGL Too High!
P17	DI19	MH6	1.00	27.56	27.56	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.57	7.08	HGL Too High!
P32	DI23	MH12	1.00	30.20	30.20	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.22	4.24	HGL Too High!
P31	DI9	MH12	1.00	30.20	30.20	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.21	7.13	HGL Too High!
P30	MH12	MH11	1.60	30.18	30.18	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	30.20	7.48	HGL Too High!
P27	MH11	MH10	1.60	30.07	30.07	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	30.18	7.21	HGL Too High!
P25	MH10	MH9	1.60	30.03	30.03	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	30.07	7.54	HGL Too High!
P22	MH9	MH8	1.60	29.95	29.95	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	30.03	7.85	HGL Too High!
P20	MH8	MH21	1.60	29.85	29.85	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	29.95	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	29.78	29.78	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	29.85	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	29.78	29.78	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	29.83	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	29.95	29.95	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	29.98	7.34	HGL Too High!

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Hydraulic Grade Line Computations

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County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	30.24	30.24	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	30.56	4.78	HGL Too High!
P51	STUB	DI22	1.00	30.24	30.24	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	30.29	7.16	HGL Too High!
P28	DI22	MH11	1.00	30.18	30.18	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	30.24	6.74	HGL Too High!
P29	DI8	MH11	1.00	30.18	30.18	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.18	6.92	HGL Too High!
P26	DI21	MH10	1.00	30.07	30.07	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.07	7.23	HGL Too High!
P23	DI20	MH9	1.00	30.03	30.03	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	30.03	7.38	HGL Too High!
P24	DI7	MH9	1.00	30.03	30.03	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.03	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	78.44	78.44	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.44	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	78.44	78.44	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.45	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	78.25	78.25	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	78.44	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	78.01	78.01	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	78.25	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	76.88	76.88	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	78.01	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	76.15	76.15	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	76.88	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	60.55	60.55	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	76.15	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	50.01	50.01	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	60.55	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	32.02	32.02	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	50.01	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	29.78	29.78	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	32.02	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	27.20	27.20	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	29.78	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	26.15	26.15	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	27.20	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	17.90	17.90	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	26.15	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.02	12.02	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	17.90	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.00**	**9.00**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	0.5	**0.85**	**3.02**	**12.02**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	80.64	80.64	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	90.60	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	80.64	80.64	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	80.67	6.45	HGL Too High!
P3	DI14	DI13	1.00	80.64	80.64	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	80.65	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	78.25	78.25	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	80.64	6.58	HGL Too High!
P2	DI2	DI1	1.00	78.03	78.03	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.04	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	78.01	78.01	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	78.03	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	81.65	81.65	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	81.67	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	81.65	81.65	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	83.58	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	76.15	76.15	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	81.65	8.13	HGL Too High!
P42	DI31	MH22	1.00	61.74	61.74	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	61.82	5.12	HGL Too High!
P43	MH22	DI32	1.00	61.68	61.68	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	61.74	5.45	HGL Too High!
P44	DI32	EX	1.00	60.55	60.55	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	61.68	5.23	HGL Too High!
P46	DI34	DI33	1.00	61.82	61.82	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	61.82	5.47	HGL Too High!
P45	DI33	DI32	1.00	61.68	61.68	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	61.82	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	32.02	32.02	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	32.02	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	76.65	76.65	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	76.87	3.63	HGL Too High!
P48	DI40	DI41	0.80	76.65	76.65	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	76.68	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	76.15	76.15	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	76.65	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	28.43	28.43	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.43	7.41	
P5	MH1	MH2	1.20	28.41	28.41	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	28.43	7.93	HGL Too High!
P7	MH2	MH3	1.20	28.37	28.37	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	28.41	7.65	HGL Too High!
P10	MH3	MH4	1.20	28.29	28.29	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	28.37	7.28	HGL Too High!
P13	MH4	MH5	1.20	28.03	28.03	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	28.29	7.09	HGL Too High!
P15	MH5	MH20	1.60	27.70	27.70	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	28.03	7.40	HGL Too High!
P6	DI16	MH2	1.00	28.41	28.41	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.41	7.33	HGL Too High!
P9	DI3	MH3	1.00	28.37	28.37	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.38	6.62	HGL Too High!
P8	DI17	MH3	1.00	28.37	28.37	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.38	6.96	HGL Too High!
P12	DI4	MH4	1.00	28.29	28.29	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	28.31	6.48	HGL Too High!
P11	DI18	MH4	1.00	28.29	28.29	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.31	6.56	HGL Too High!
P14	DI5	MH5	1.00	28.03	28.03	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.04	6.61	HGL Too High!
P18	DI6	MH6	1.00	28.06	28.06	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	28.09	7.13	HGL Too High!
P16	MH6	MH5	1.20	28.03	28.03	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	28.06	7.55	HGL Too High!
P17	DI19	MH6	1.00	28.06	28.06	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.07	7.08	HGL Too High!
P32	DI23	MH12	1.00	30.70	30.70	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.72	4.24	HGL Too High!
P31	DI9	MH12	1.00	30.70	30.70	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.71	7.13	HGL Too High!
P30	MH12	MH11	1.60	30.68	30.68	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	30.70	7.48	HGL Too High!
P27	MH11	MH10	1.60	30.57	30.57	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	30.68	7.21	HGL Too High!
P25	MH10	MH9	1.60	30.53	30.53	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	30.57	7.54	HGL Too High!
P22	MH9	MH8	1.60	30.45	30.45	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	30.53	7.85	HGL Too High!
P20	MH8	MH21	1.60	30.35	30.35	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	30.45	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	30.28	30.28	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	30.35	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	30.28	30.28	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	30.33	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	30.45	30.45	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	30.48	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	30.74	30.74	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	31.06	4.78	HGL Too High!
P51	STUB	DI22	1.00	30.74	30.74	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	30.79	7.16	HGL Too High!
P28	DI22	MH11	1.00	30.68	30.68	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	30.74	6.74	HGL Too High!
P29	DI8	MH11	1.00	30.68	30.68	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.68	6.92	HGL Too High!
P26	DI21	MH10	1.00	30.57	30.57	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.57	7.23	HGL Too High!
P23	DI20	MH9	1.00	30.53	30.53	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	30.53	7.38	HGL Too High!
P24	DI7	MH9	1.00	30.53	30.53	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.53	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	78.94	78.94	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.94	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	78.94	78.94	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.95	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	78.75	78.75	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	78.94	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	78.51	78.51	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	78.75	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	77.38	77.38	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	78.51	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	76.65	76.65	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	77.38	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	61.05	61.05	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	76.65	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	50.51	50.51	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	61.05	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	32.52	32.52	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	50.51	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	30.28	30.28	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	32.52	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	27.70	27.70	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	30.28	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	26.65	26.65	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	27.70	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	18.40	18.40	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	26.65	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.52	12.52	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	18.40	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.50**	**9.50**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	0.5	**0.85**	**3.02**	**12.52**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	81.14	81.14	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	91.10	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	81.14	81.14	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	81.17	6.45	HGL Too High!
P3	DI14	DI13	1.00	81.14	81.14	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.15	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	78.75	78.75	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	81.14	6.58	HGL Too High!
P2	DI2	DI1	1.00	78.53	78.53	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.54	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	78.51	78.51	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	78.53	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	82.15	82.15	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	82.17	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	82.15	82.15	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	84.08	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	76.65	76.65	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	82.15	8.13	HGL Too High!
P42	DI31	MH22	1.00	62.24	62.24	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	62.32	5.12	HGL Too High!
P43	MH22	DI32	1.00	62.18	62.18	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	62.24	5.45	HGL Too High!
P44	DI32	EX	1.00	61.05	61.05	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	62.18	5.23	HGL Too High!
P46	DI34	DI33	1.00	62.32	62.32	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	62.32	5.47	HGL Too High!
P45	DI33	DI32	1.00	62.18	62.18	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	62.32	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	32.52	32.52	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	32.52	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	77.15	77.15	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	77.37	3.63	HGL Too High!
P48	DI40	DI41	0.80	77.15	77.15	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	77.18	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	76.65	76.65	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	77.15	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	29.73	29.73	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.73	7.41	
P5	MH1	MH2	1.20	29.71	29.71	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	29.73	7.93	HGL Too High!
P7	MH2	MH3	1.20	29.67	29.67	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	29.71	7.65	HGL Too High!
P10	MH3	MH4	1.20	29.59	29.59	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	29.67	7.28	HGL Too High!
P13	MH4	MH5	1.20	29.33	29.33	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	29.59	7.09	HGL Too High!
P15	MH5	MH20	1.60	29.00	29.00	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	29.33	7.40	HGL Too High!
P6	DI16	MH2	1.00	29.71	29.71	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.71	7.33	HGL Too High!
P9	DI3	MH3	1.00	29.67	29.67	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.68	6.62	HGL Too High!
P8	DI17	MH3	1.00	29.67	29.67	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.68	6.96	HGL Too High!
P12	DI4	MH4	1.00	29.59	29.59	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	29.61	6.48	HGL Too High!
P11	DI18	MH4	1.00	29.59	29.59	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.61	6.56	HGL Too High!
P14	DI5	MH5	1.00	29.33	29.33	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.34	6.61	HGL Too High!
P18	DI6	MH6	1.00	29.36	29.36	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	29.39	7.13	HGL Too High!
P16	MH6	MH5	1.20	29.33	29.33	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	29.36	7.55	HGL Too High!
P17	DI19	MH6	1.00	29.36	29.36	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.37	7.08	HGL Too High!
P32	DI23	MH12	1.00	32.00	32.00	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.02	4.24	HGL Too High!
P31	DI9	MH12	1.00	32.00	32.00	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.01	7.13	HGL Too High!
P30	MH12	MH11	1.60	31.98	31.98	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	32.00	7.48	HGL Too High!
P27	MH11	MH10	1.60	31.87	31.87	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	31.98	7.21	HGL Too High!
P25	MH10	MH9	1.60	31.83	31.83	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	31.87	7.54	HGL Too High!
P22	MH9	MH8	1.60	31.75	31.75	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	31.83	7.85	HGL Too High!
P20	MH8	MH21	1.60	31.65	31.65	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	31.75	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	31.58	31.58	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	31.65	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	31.58	31.58	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	31.63	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	31.75	31.75	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	31.78	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	32.04	32.04	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	32.36	4.78	HGL Too High!
P51	STUB	DI22	1.00	32.04	32.04	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	32.09	7.16	HGL Too High!
P28	DI22	MH11	1.00	31.98	31.98	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	32.04	6.74	HGL Too High!
P29	DI8	MH11	1.00	31.98	31.98	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.98	6.92	HGL Too High!
P26	DI21	MH10	1.00	31.87	31.87	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.87	7.23	HGL Too High!
P23	DI20	MH9	1.00	31.83	31.83	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	31.83	7.38	HGL Too High!
P24	DI7	MH9	1.00	31.83	31.83	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.83	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	80.24	80.24	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	80.24	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	80.24	80.24	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	80.25	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	80.05	80.05	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	80.24	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	79.81	79.81	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	80.05	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	78.68	78.68	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	79.81	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	77.95	77.95	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	78.68	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	62.35	62.35	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	77.95	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	51.81	51.81	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	62.35	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	33.82	33.82	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	51.81	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	31.58	31.58	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	33.82	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	29.00	29.00	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	31.58	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	27.95	27.95	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	29.00	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	19.70	19.70	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	27.95	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.82	13.82	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	19.70	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.80**	**10.80**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**13.82**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	82.44	82.44	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	92.40	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	82.44	82.44	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	82.47	6.45	HGL Too High!
P3	DI14	DI13	1.00	82.44	82.44	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	82.45	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	80.05	80.05	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	82.44	6.58	HGL Too High!
P2	DI2	DI1	1.00	79.83	79.83	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	79.84	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	79.81	79.81	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	79.83	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	83.45	83.45	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	83.47	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	83.45	83.45	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	85.38	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	77.95	77.95	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	83.45	8.13	HGL Too High!
P42	DI31	MH22	1.00	63.54	63.54	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	63.62	5.12	HGL Too High!
P43	MH22	DI32	1.00	63.48	63.48	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	63.54	5.45	HGL Too High!
P44	DI32	EX	1.00	62.35	62.35	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	63.48	5.23	HGL Too High!
P46	DI34	DI33	1.00	63.62	63.62	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	63.62	5.47	HGL Too High!
P45	DI33	DI32	1.00	63.48	63.48	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	63.62	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	33.82	33.82	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	33.82	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	78.45	78.45	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	78.67	3.63	HGL Too High!
P48	DI40	DI41	0.80	78.45	78.45	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	78.48	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	77.95	77.95	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	78.45	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	24.67	24.67	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.67	7.41	
P5	MH1	MH2	1.20	24.65	24.65	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	24.67	7.93	HGL Too High!
P7	MH2	MH3	1.20	24.61	24.61	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	24.65	7.65	HGL Too High!
P10	MH3	MH4	1.20	24.53	24.53	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	24.61	7.28	HGL Too High!
P13	MH4	MH5	1.20	24.27	24.27	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	24.53	7.09	HGL Too High!
P15	MH5	MH20	1.60	23.94	23.94	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	24.27	7.40	HGL Too High!
P6	DI16	MH2	1.00	24.65	24.65	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.65	7.33	HGL Too High!
P9	DI3	MH3	1.00	24.61	24.61	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.62	6.62	HGL Too High!
P8	DI17	MH3	1.00	24.61	24.61	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.62	6.96	HGL Too High!
P12	DI4	MH4	1.00	24.53	24.53	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	24.55	6.48	HGL Too High!
P11	DI18	MH4	1.00	24.53	24.53	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.55	6.56	HGL Too High!
P14	DI5	MH5	1.00	24.27	24.27	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.28	6.61	HGL Too High!
P18	DI6	MH6	1.00	24.30	24.30	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	24.33	7.13	HGL Too High!
P16	MH6	MH5	1.20	24.27	24.27	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	24.30	7.55	HGL Too High!
P17	DI19	MH6	1.00	24.30	24.30	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.31	7.08	HGL Too High!
P32	DI23	MH12	1.00	26.94	26.94	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.96	4.24	HGL Too High!
P31	DI9	MH12	1.00	26.94	26.94	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.95	7.13	HGL Too High!
P30	MH12	MH11	1.60	26.92	26.92	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	26.94	7.48	HGL Too High!
P27	MH11	MH10	1.60	26.81	26.81	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	26.92	7.21	HGL Too High!
P25	MH10	MH9	1.60	26.77	26.77	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	26.81	7.54	HGL Too High!
P22	MH9	MH8	1.60	26.69	26.69	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	26.77	7.85	HGL Too High!
P20	MH8	MH21	1.60	26.59	26.59	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	26.69	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	26.52	26.52	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	26.59	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	26.52	26.52	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	26.57	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	26.69	26.69	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	26.72	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	26.98	26.98	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	27.30	4.78	HGL Too High!
P51	STUB	DI22	1.00	26.98	26.98	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	27.03	7.16	HGL Too High!
P28	DI22	MH11	1.00	26.92	26.92	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	26.98	6.74	HGL Too High!
P29	DI8	MH11	1.00	26.92	26.92	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.92	6.92	HGL Too High!
P26	DI21	MH10	1.00	26.81	26.81	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.81	7.23	HGL Too High!
P23	DI20	MH9	1.00	26.77	26.77	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	26.77	7.38	HGL Too High!
P24	DI7	MH9	1.00	26.77	26.77	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.77	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	75.18	75.18	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	75.18	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	75.18	75.18	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	75.19	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	74.99	74.99	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	75.18	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	74.75	74.75	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	74.99	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	73.62	73.62	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	74.75	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	72.89	72.89	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	73.62	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	57.29	57.29	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	72.89	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	46.75	46.75	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	57.29	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	28.76	28.76	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	46.75	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	26.52	26.52	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	28.76	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	23.94	23.94	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	26.52	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	22.89	22.89	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	23.94	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	14.64	14.64	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	22.89	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	8.76	8.76	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	14.64	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.74**	**5.74**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**8.76**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	77.38	77.38	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	87.34	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	77.38	77.38	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	77.41	6.45	HGL Too High!
P3	DI14	DI13	1.00	77.38	77.38	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	77.39	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	74.99	74.99	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	77.38	6.58	HGL Too High!
P2	DI2	DI1	1.00	74.77	74.77	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	74.78	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	74.75	74.75	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	74.77	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	78.39	78.39	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	78.41	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	78.39	78.39	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	80.32	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	72.89	72.89	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	78.39	8.13	HGL Too High!
P42	DI31	MH22	1.00	58.48	58.48	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	58.56	5.12	HGL Too High!
P43	MH22	DI32	1.00	58.42	58.42	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	58.48	5.45	HGL Too High!
P44	DI32	EX	1.00	57.29	57.29	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	58.42	5.23	HGL Too High!
P46	DI34	DI33	1.00	58.56	58.56	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	58.56	5.47	HGL Too High!
P45	DI33	DI32	1.00	58.42	58.42	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	58.56	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	28.76	28.76	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	28.76	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	73.39	73.39	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	73.61	3.63	HGL Too High!
P48	DI40	DI41	0.80	73.39	73.39	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	73.42	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	72.89	72.89	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	73.39	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	24.87	24.87	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.87	7.41	
P5	MH1	MH2	1.20	24.85	24.85	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	24.87	7.93	HGL Too High!
P7	MH2	MH3	1.20	24.81	24.81	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	24.85	7.65	HGL Too High!
P10	MH3	MH4	1.20	24.73	24.73	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	24.81	7.28	HGL Too High!
P13	MH4	MH5	1.20	24.47	24.47	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	24.73	7.09	HGL Too High!
P15	MH5	MH20	1.60	24.14	24.14	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	24.47	7.40	HGL Too High!
P6	DI16	MH2	1.00	24.85	24.85	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.85	7.33	HGL Too High!
P9	DI3	MH3	1.00	24.81	24.81	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.82	6.62	HGL Too High!
P8	DI17	MH3	1.00	24.81	24.81	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.82	6.96	HGL Too High!
P12	DI4	MH4	1.00	24.73	24.73	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	24.75	6.48	HGL Too High!
P11	DI18	MH4	1.00	24.73	24.73	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.75	6.56	HGL Too High!
P14	DI5	MH5	1.00	24.47	24.47	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.48	6.61	HGL Too High!
P18	DI6	MH6	1.00	24.50	24.50	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	24.53	7.13	HGL Too High!
P16	MH6	MH5	1.20	24.47	24.47	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	24.50	7.55	HGL Too High!
P17	DI19	MH6	1.00	24.50	24.50	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.51	7.08	HGL Too High!
P32	DI23	MH12	1.00	27.14	27.14	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.16	4.24	HGL Too High!
P31	DI9	MH12	1.00	27.14	27.14	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.15	7.13	HGL Too High!
P30	MH12	MH11	1.60	27.12	27.12	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	27.14	7.48	HGL Too High!
P27	MH11	MH10	1.60	27.01	27.01	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	27.12	7.21	HGL Too High!
P25	MH10	MH9	1.60	26.97	26.97	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	27.01	7.54	HGL Too High!
P22	MH9	MH8	1.60	26.89	26.89	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	26.97	7.85	HGL Too High!
P20	MH8	MH21	1.60	26.79	26.79	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	26.89	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	26.72	26.72	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	26.79	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	26.72	26.72	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	26.77	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	26.89	26.89	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	26.92	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	27.18	27.18	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	27.50	4.78	HGL Too High!
P51	STUB	DI22	1.00	27.18	27.18	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	27.23	7.16	HGL Too High!
P28	DI22	MH11	1.00	27.12	27.12	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	27.18	6.74	HGL Too High!
P29	DI8	MH11	1.00	27.12	27.12	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.12	6.92	HGL Too High!
P26	DI21	MH10	1.00	27.01	27.01	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.01	7.23	HGL Too High!
P23	DI20	MH9	1.00	26.97	26.97	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	26.97	7.38	HGL Too High!
P24	DI7	MH9	1.00	26.97	26.97	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.97	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	75.38	75.38	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	75.38	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	75.38	75.38	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	75.39	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	75.19	75.19	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	75.38	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	74.95	74.95	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	75.19	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	73.82	73.82	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	74.95	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	73.09	73.09	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	73.82	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	57.49	57.49	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	73.09	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	46.95	46.95	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	57.49	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	28.96	28.96	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	46.95	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	26.72	26.72	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	28.96	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	24.14	24.14	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	26.72	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	23.09	23.09	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	24.14	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	14.84	14.84	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	23.09	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	8.96	8.96	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	14.84	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.94**	**5.94**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**8.96**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	77.58	77.58	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	87.54	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	77.58	77.58	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	77.61	6.45	HGL Too High!
P3	DI14	DI13	1.00	77.58	77.58	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	77.59	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	75.19	75.19	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	77.58	6.58	HGL Too High!
P2	DI2	DI1	1.00	74.97	74.97	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	74.98	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	74.95	74.95	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	74.97	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	78.59	78.59	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	78.61	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	78.59	78.59	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	80.52	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	73.09	73.09	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	78.59	8.13	HGL Too High!
P42	DI31	MH22	1.00	58.68	58.68	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	58.76	5.12	HGL Too High!
P43	MH22	DI32	1.00	58.62	58.62	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	58.68	5.45	HGL Too High!
P44	DI32	EX	1.00	57.49	57.49	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	58.62	5.23	HGL Too High!
P46	DI34	DI33	1.00	58.76	58.76	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	58.76	5.47	HGL Too High!
P45	DI33	DI32	1.00	58.62	58.62	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	58.76	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	28.96	28.96	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	28.96	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	73.59	73.59	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	73.81	3.63	HGL Too High!
P48	DI40	DI41	0.80	73.59	73.59	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	73.62	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	73.09	73.09	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	73.59	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	28.37	28.37	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.37	7.41	
P5	MH1	MH2	1.20	28.35	28.35	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	28.37	7.93	HGL Too High!
P7	MH2	MH3	1.20	28.31	28.31	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	28.35	7.65	HGL Too High!
P10	MH3	MH4	1.20	28.23	28.23	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	28.31	7.28	HGL Too High!
P13	MH4	MH5	1.20	27.97	27.97	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	28.23	7.09	HGL Too High!
P15	MH5	MH20	1.60	27.64	27.64	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	27.97	7.40	HGL Too High!
P6	DI16	MH2	1.00	28.35	28.35	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.35	7.33	HGL Too High!
P9	DI3	MH3	1.00	28.31	28.31	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.32	6.62	HGL Too High!
P8	DI17	MH3	1.00	28.31	28.31	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.32	6.96	HGL Too High!
P12	DI4	MH4	1.00	28.23	28.23	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	28.25	6.48	HGL Too High!
P11	DI18	MH4	1.00	28.23	28.23	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.25	6.56	HGL Too High!
P14	DI5	MH5	1.00	27.97	27.97	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.98	6.61	HGL Too High!
P18	DI6	MH6	1.00	28.00	28.00	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	28.03	7.13	HGL Too High!
P16	MH6	MH5	1.20	27.97	27.97	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	28.00	7.55	HGL Too High!
P17	DI19	MH6	1.00	28.00	28.00	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.01	7.08	HGL Too High!
P32	DI23	MH12	1.00	30.64	30.64	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.66	4.24	HGL Too High!
P31	DI9	MH12	1.00	30.64	30.64	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.65	7.13	HGL Too High!
P30	MH12	MH11	1.60	30.62	30.62	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	30.64	7.48	HGL Too High!
P27	MH11	MH10	1.60	30.51	30.51	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	30.62	7.21	HGL Too High!
P25	MH10	MH9	1.60	30.47	30.47	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	30.51	7.54	HGL Too High!
P22	MH9	MH8	1.60	30.39	30.39	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	30.47	7.85	HGL Too High!
P20	MH8	MH21	1.60	30.29	30.29	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	30.39	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	30.22	30.22	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	30.29	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	30.22	30.22	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	30.27	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	30.39	30.39	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	30.42	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	30.68	30.68	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	31.00	4.78	HGL Too High!
P51	STUB	DI22	1.00	30.68	30.68	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	30.73	7.16	HGL Too High!
P28	DI22	MH11	1.00	30.62	30.62	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	30.68	6.74	HGL Too High!
P29	DI8	MH11	1.00	30.62	30.62	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.62	6.92	HGL Too High!
P26	DI21	MH10	1.00	30.51	30.51	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.51	7.23	HGL Too High!
P23	DI20	MH9	1.00	30.47	30.47	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	30.47	7.38	HGL Too High!
P24	DI7	MH9	1.00	30.47	30.47	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.47	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	78.88	78.88	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.88	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	78.88	78.88	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.89	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	78.69	78.69	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	78.88	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	78.45	78.45	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	78.69	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	77.32	77.32	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	78.45	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	76.59	76.59	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	77.32	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	60.99	60.99	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	76.59	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	50.45	50.45	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	60.99	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	32.46	32.46	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	50.45	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	30.22	30.22	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	32.46	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	27.64	27.64	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	30.22	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	26.59	26.59	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	27.64	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	18.34	18.34	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	26.59	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.46	12.46	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	18.34	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.44**	**9.44**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**12.46**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	81.08	81.08	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	91.04	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	81.08	81.08	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	81.11	6.45	HGL Too High!
P3	DI14	DI13	1.00	81.08	81.08	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.09	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	78.69	78.69	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	81.08	6.58	HGL Too High!
P2	DI2	DI1	1.00	78.47	78.47	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.48	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	78.45	78.45	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	78.47	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	82.09	82.09	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	82.11	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	82.09	82.09	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	84.02	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	76.59	76.59	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	82.09	8.13	HGL Too High!
P42	DI31	MH22	1.00	62.18	62.18	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	62.26	5.12	HGL Too High!
P43	MH22	DI32	1.00	62.12	62.12	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	62.18	5.45	HGL Too High!
P44	DI32	EX	1.00	60.99	60.99	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	62.12	5.23	HGL Too High!
P46	DI34	DI33	1.00	62.26	62.26	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	62.26	5.47	HGL Too High!
P45	DI33	DI32	1.00	62.12	62.12	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	62.26	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	32.46	32.46	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	32.46	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	77.09	77.09	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	77.31	3.63	HGL Too High!
P48	DI40	DI41	0.80	77.09	77.09	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	77.12	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	76.59	76.59	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	77.09	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	28.87	28.87	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.87	7.41	
P5	MH1	MH2	1.20	28.85	28.85	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	28.87	7.93	HGL Too High!
P7	MH2	MH3	1.20	28.81	28.81	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	28.85	7.65	HGL Too High!
P10	MH3	MH4	1.20	28.73	28.73	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	28.81	7.28	HGL Too High!
P13	MH4	MH5	1.20	28.47	28.47	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	28.73	7.09	HGL Too High!
P15	MH5	MH20	1.60	28.14	28.14	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	28.47	7.40	HGL Too High!
P6	DI16	MH2	1.00	28.85	28.85	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.85	7.33	HGL Too High!
P9	DI3	MH3	1.00	28.81	28.81	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.82	6.62	HGL Too High!
P8	DI17	MH3	1.00	28.81	28.81	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.82	6.96	HGL Too High!
P12	DI4	MH4	1.00	28.73	28.73	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	28.75	6.48	HGL Too High!
P11	DI18	MH4	1.00	28.73	28.73	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.75	6.56	HGL Too High!
P14	DI5	MH5	1.00	28.47	28.47	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.48	6.61	HGL Too High!
P18	DI6	MH6	1.00	28.50	28.50	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	28.53	7.13	HGL Too High!
P16	MH6	MH5	1.20	28.47	28.47	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	28.50	7.55	HGL Too High!
P17	DI19	MH6	1.00	28.50	28.50	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.51	7.08	HGL Too High!
P32	DI23	MH12	1.00	31.14	31.14	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.16	4.24	HGL Too High!
P31	DI9	MH12	1.00	31.14	31.14	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.15	7.13	HGL Too High!
P30	MH12	MH11	1.60	31.12	31.12	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	31.14	7.48	HGL Too High!
P27	MH11	MH10	1.60	31.01	31.01	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	31.12	7.21	HGL Too High!
P25	MH10	MH9	1.60	30.97	30.97	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	31.01	7.54	HGL Too High!
P22	MH9	MH8	1.60	30.89	30.89	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	30.97	7.85	HGL Too High!
P20	MH8	MH21	1.60	30.79	30.79	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	30.89	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	30.72	30.72	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	30.79	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	30.72	30.72	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	30.77	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	30.89	30.89	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	30.92	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	31.18	31.18	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	31.50	4.78	HGL Too High!
P51	STUB	DI22	1.00	31.18	31.18	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	31.23	7.16	HGL Too High!
P28	DI22	MH11	1.00	31.12	31.12	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	31.18	6.74	HGL Too High!
P29	DI8	MH11	1.00	31.12	31.12	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.12	6.92	HGL Too High!
P26	DI21	MH10	1.00	31.01	31.01	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.01	7.23	HGL Too High!
P23	DI20	MH9	1.00	30.97	30.97	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	30.97	7.38	HGL Too High!
P24	DI7	MH9	1.00	30.97	30.97	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.97	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	79.38	79.38	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	79.38	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	79.38	79.38	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	79.39	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	79.19	79.19	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	79.38	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	78.95	78.95	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	79.19	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	77.82	77.82	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	78.95	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	77.09	77.09	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	77.82	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	61.49	61.49	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	77.09	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	50.95	50.95	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	61.49	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	32.96	32.96	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	50.95	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	30.72	30.72	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	32.96	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	28.14	28.14	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	30.72	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	27.09	27.09	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	28.14	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	18.84	18.84	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	27.09	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.96	12.96	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	18.84	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.94**	**9.94**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**12.96**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	81.58	81.58	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	91.54	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	81.58	81.58	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	81.61	6.45	HGL Too High!
P3	DI14	DI13	1.00	81.58	81.58	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.59	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	79.19	79.19	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	81.58	6.58	HGL Too High!
P2	DI2	DI1	1.00	78.97	78.97	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.98	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	78.95	78.95	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	78.97	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	82.59	82.59	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	82.61	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	82.59	82.59	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	84.52	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	77.09	77.09	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	82.59	8.13	HGL Too High!
P42	DI31	MH22	1.00	62.68	62.68	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	62.76	5.12	HGL Too High!
P43	MH22	DI32	1.00	62.62	62.62	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	62.68	5.45	HGL Too High!
P44	DI32	EX	1.00	61.49	61.49	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	62.62	5.23	HGL Too High!
P46	DI34	DI33	1.00	62.76	62.76	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	62.76	5.47	HGL Too High!
P45	DI33	DI32	1.00	62.62	62.62	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	62.76	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	32.96	32.96	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	32.96	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	77.59	77.59	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	77.81	3.63	HGL Too High!
P48	DI40	DI41	0.80	77.59	77.59	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	77.62	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	77.09	77.09	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	77.59	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	29.27	29.27	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.27	7.41	
P5	MH1	MH2	1.20	29.25	29.25	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	29.27	7.93	HGL Too High!
P7	MH2	MH3	1.20	29.21	29.21	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	29.25	7.65	HGL Too High!
P10	MH3	MH4	1.20	29.13	29.13	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	29.21	7.28	HGL Too High!
P13	MH4	MH5	1.20	28.87	28.87	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	29.13	7.09	HGL Too High!
P15	MH5	MH20	1.60	28.54	28.54	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	28.87	7.40	HGL Too High!
P6	DI16	MH2	1.00	29.25	29.25	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.25	7.33	HGL Too High!
P9	DI3	MH3	1.00	29.21	29.21	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.22	6.62	HGL Too High!
P8	DI17	MH3	1.00	29.21	29.21	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.22	6.96	HGL Too High!
P12	DI4	MH4	1.00	29.13	29.13	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	29.15	6.48	HGL Too High!
P11	DI18	MH4	1.00	29.13	29.13	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.15	6.56	HGL Too High!
P14	DI5	MH5	1.00	28.87	28.87	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.88	6.61	HGL Too High!
P18	DI6	MH6	1.00	28.90	28.90	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	28.93	7.13	HGL Too High!
P16	MH6	MH5	1.20	28.87	28.87	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	28.90	7.55	HGL Too High!
P17	DI19	MH6	1.00	28.90	28.90	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.91	7.08	HGL Too High!
P32	DI23	MH12	1.00	31.54	31.54	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.56	4.24	HGL Too High!
P31	DI9	MH12	1.00	31.54	31.54	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.55	7.13	HGL Too High!
P30	MH12	MH11	1.60	31.52	31.52	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	31.54	7.48	HGL Too High!
P27	MH11	MH10	1.60	31.41	31.41	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	31.52	7.21	HGL Too High!
P25	MH10	MH9	1.60	31.37	31.37	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	31.41	7.54	HGL Too High!
P22	MH9	MH8	1.60	31.29	31.29	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	31.37	7.85	HGL Too High!
P20	MH8	MH21	1.60	31.19	31.19	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	31.29	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	31.12	31.12	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	31.19	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	31.12	31.12	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	31.17	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	31.29	31.29	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	31.32	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	31.58	31.58	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	31.90	4.78	HGL Too High!
P51	STUB	DI22	1.00	31.58	31.58	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	31.63	7.16	HGL Too High!
P28	DI22	MH11	1.00	31.52	31.52	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	31.58	6.74	HGL Too High!
P29	DI8	MH11	1.00	31.52	31.52	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.52	6.92	HGL Too High!
P26	DI21	MH10	1.00	31.41	31.41	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.41	7.23	HGL Too High!
P23	DI20	MH9	1.00	31.37	31.37	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	31.37	7.38	HGL Too High!
P24	DI7	MH9	1.00	31.37	31.37	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.37	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	79.78	79.78	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	79.78	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	79.78	79.78	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	79.79	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	79.59	79.59	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	79.78	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	79.35	79.35	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	79.59	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	78.22	78.22	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	79.35	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	77.49	77.49	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	78.22	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	61.89	61.89	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	77.49	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	51.35	51.35	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	61.89	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	33.36	33.36	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	51.35	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	31.12	31.12	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	33.36	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	28.54	28.54	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	31.12	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	27.49	27.49	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	28.54	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	19.24	19.24	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	27.49	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.36	13.36	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	19.24	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.34**	**10.34**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**13.36**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	81.98	81.98	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	91.94	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	81.98	81.98	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	82.01	6.45	HGL Too High!
P3	DI14	DI13	1.00	81.98	81.98	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.99	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	79.59	79.59	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	81.98	6.58	HGL Too High!
P2	DI2	DI1	1.00	79.37	79.37	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	79.38	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	79.35	79.35	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	79.37	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	82.99	82.99	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	83.01	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	82.99	82.99	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	84.92	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	77.49	77.49	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	82.99	8.13	HGL Too High!
P42	DI31	MH22	1.00	63.08	63.08	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	63.16	5.12	HGL Too High!
P43	MH22	DI32	1.00	63.02	63.02	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	63.08	5.45	HGL Too High!
P44	DI32	EX	1.00	61.89	61.89	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	63.02	5.23	HGL Too High!
P46	DI34	DI33	1.00	63.16	63.16	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	63.16	5.47	HGL Too High!
P45	DI33	DI32	1.00	63.02	63.02	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	63.16	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	33.36	33.36	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	33.36	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	77.99	77.99	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	78.21	3.63	HGL Too High!
P48	DI40	DI41	0.80	77.99	77.99	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	78.02	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	77.49	77.49	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	77.99	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	29.77	29.77	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.77	7.41	
P5	MH1	MH2	1.20	29.75	29.75	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	29.77	7.93	HGL Too High!
P7	MH2	MH3	1.20	29.71	29.71	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	29.75	7.65	HGL Too High!
P10	MH3	MH4	1.20	29.63	29.63	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	29.71	7.28	HGL Too High!
P13	MH4	MH5	1.20	29.37	29.37	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	29.63	7.09	HGL Too High!
P15	MH5	MH20	1.60	29.04	29.04	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	29.37	7.40	HGL Too High!
P6	DI16	MH2	1.00	29.75	29.75	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.75	7.33	HGL Too High!
P9	DI3	MH3	1.00	29.71	29.71	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.72	6.62	HGL Too High!
P8	DI17	MH3	1.00	29.71	29.71	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.72	6.96	HGL Too High!
P12	DI4	MH4	1.00	29.63	29.63	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	29.65	6.48	HGL Too High!
P11	DI18	MH4	1.00	29.63	29.63	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.65	6.56	HGL Too High!
P14	DI5	MH5	1.00	29.37	29.37	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.38	6.61	HGL Too High!
P18	DI6	MH6	1.00	29.40	29.40	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	29.43	7.13	HGL Too High!
P16	MH6	MH5	1.20	29.37	29.37	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	29.40	7.55	HGL Too High!
P17	DI19	MH6	1.00	29.40	29.40	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.41	7.08	HGL Too High!
P32	DI23	MH12	1.00	32.04	32.04	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.06	4.24	HGL Too High!
P31	DI9	MH12	1.00	32.04	32.04	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.05	7.13	HGL Too High!
P30	MH12	MH11	1.60	32.02	32.02	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	32.04	7.48	HGL Too High!
P27	MH11	MH10	1.60	31.91	31.91	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	32.02	7.21	HGL Too High!
P25	MH10	MH9	1.60	31.87	31.87	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	31.91	7.54	HGL Too High!
P22	MH9	MH8	1.60	31.79	31.79	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	31.87	7.85	HGL Too High!
P20	MH8	MH21	1.60	31.69	31.69	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	31.79	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	31.62	31.62	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	31.69	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	31.62	31.62	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	31.67	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	31.79	31.79	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	31.82	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t= H_o +H_f +H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	32.08	32.08	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	32.40	4.78	HGL Too High!
P51	STUB	DI22	1.00	32.08	32.08	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	32.13	7.16	HGL Too High!
P28	DI22	MH11	1.00	32.02	32.02	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	32.08	6.74	HGL Too High!
P29	DI8	MH11	1.00	32.02	32.02	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.02	6.92	HGL Too High!
P26	DI21	MH10	1.00	31.91	31.91	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.91	7.23	HGL Too High!
P23	DI20	MH9	1.00	31.87	31.87	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	31.87	7.38	HGL Too High!
P24	DI7	MH9	1.00	31.87	31.87	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.87	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	80.28	80.28	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	80.28	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	80.28	80.28	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	80.29	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	80.09	80.09	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	80.28	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	79.85	79.85	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	80.09	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	78.72	78.72	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	79.85	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	77.99	77.99	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	78.72	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	62.39	62.39	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	77.99	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	51.85	51.85	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	62.39	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	33.86	33.86	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	51.85	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	31.62	31.62	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	33.86	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	29.04	29.04	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	31.62	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	27.99	27.99	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	29.04	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	19.74	19.74	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	27.99	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.86	13.86	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	19.74	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.84**	**10.84**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**13.86**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	82.48	82.48	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	92.44	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	82.48	82.48	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	82.51	6.45	HGL Too High!
P3	DI14	DI13	1.00	82.48	82.48	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	82.49	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	80.09	80.09	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	82.48	6.58	HGL Too High!
P2	DI2	DI1	1.00	79.87	79.87	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	79.88	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

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County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	79.85	79.85	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	79.87	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	83.49	83.49	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	83.51	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	83.49	83.49	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	85.42	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	77.99	77.99	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	83.49	8.13	HGL Too High!
P42	DI31	MH22	1.00	63.58	63.58	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	63.66	5.12	HGL Too High!
P43	MH22	DI32	1.00	63.52	63.52	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	63.58	5.45	HGL Too High!
P44	DI32	EX	1.00	62.39	62.39	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	63.52	5.23	HGL Too High!
P46	DI34	DI33	1.00	63.66	63.66	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	63.66	5.47	HGL Too High!
P45	DI33	DI32	1.00	63.52	63.52	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	63.66	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	33.86	33.86	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	33.86	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	78.49	78.49	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	78.71	3.63	HGL Too High!
P48	DI40	DI41	0.80	78.49	78.49	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	78.52	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	77.99	77.99	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	78.49	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	30.47	30.47	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.47	7.41	
P5	MH1	MH2	1.20	30.45	30.45	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	30.47	7.93	HGL Too High!
P7	MH2	MH3	1.20	30.41	30.41	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	30.45	7.65	HGL Too High!
P10	MH3	MH4	1.20	30.33	30.33	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	30.41	7.28	HGL Too High!
P13	MH4	MH5	1.20	30.07	30.07	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	30.33	7.09	HGL Too High!
P15	MH5	MH20	1.60	29.74	29.74	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	30.07	7.40	HGL Too High!
P6	DI16	MH2	1.00	30.45	30.45	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.45	7.33	HGL Too High!
P9	DI3	MH3	1.00	30.41	30.41	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.42	6.62	HGL Too High!
P8	DI17	MH3	1.00	30.41	30.41	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.42	6.96	HGL Too High!
P12	DI4	MH4	1.00	30.33	30.33	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	30.35	6.48	HGL Too High!
P11	DI18	MH4	1.00	30.33	30.33	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.35	6.56	HGL Too High!
P14	DI5	MH5	1.00	30.07	30.07	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.08	6.61	HGL Too High!
P18	DI6	MH6	1.00	30.10	30.10	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	30.13	7.13	HGL Too High!
P16	MH6	MH5	1.20	30.07	30.07	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	30.10	7.55	HGL Too High!
P17	DI19	MH6	1.00	30.10	30.10	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.11	7.08	HGL Too High!
P32	DI23	MH12	1.00	32.74	32.74	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.76	4.24	HGL Too High!
P31	DI9	MH12	1.00	32.74	32.74	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.75	7.13	HGL Too High!
P30	MH12	MH11	1.60	32.72	32.72	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	32.74	7.48	HGL Too High!
P27	MH11	MH10	1.60	32.61	32.61	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	32.72	7.21	HGL Too High!
P25	MH10	MH9	1.60	32.57	32.57	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	32.61	7.54	HGL Too High!
P22	MH9	MH8	1.60	32.49	32.49	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	32.57	7.85	HGL Too High!
P20	MH8	MH21	1.60	32.39	32.39	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	32.49	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	32.32	32.32	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	32.39	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	32.32	32.32	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	32.37	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	32.49	32.49	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	32.52	7.34	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	32.78	32.78	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	33.10	4.78	HGL Too High!
P51	STUB	DI22	1.00	32.78	32.78	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	32.83	7.16	HGL Too High!
P28	DI22	MH11	1.00	32.72	32.72	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	32.78	6.74	HGL Too High!
P29	DI8	MH11	1.00	32.72	32.72	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.72	6.92	HGL Too High!
P26	DI21	MH10	1.00	32.61	32.61	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.61	7.23	HGL Too High!
P23	DI20	MH9	1.00	32.57	32.57	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	32.57	7.38	HGL Too High!
P24	DI7	MH9	1.00	32.57	32.57	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.57	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	80.98	80.98	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	80.98	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	80.98	80.98	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	80.99	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	80.79	80.79	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	80.98	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	80.55	80.55	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	80.79	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	79.42	79.42	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	80.55	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	78.69	78.69	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	79.42	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	63.09	63.09	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	78.69	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	52.55	52.55	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	63.09	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	34.56	34.56	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	52.55	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	32.32	32.32	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	34.56	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	29.74	29.74	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	32.32	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	28.69	28.69	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	29.74	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	20.44	20.44	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	28.69	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	14.56	14.56	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	20.44	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**11.54**	**11.54**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**14.56**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	83.18	83.18	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	93.14	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	83.18	83.18	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	83.21	6.45	HGL Too High!
P3	DI14	DI13	1.00	83.18	83.18	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	83.19	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	80.79	80.79	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	83.18	6.58	HGL Too High!
P2	DI2	DI1	1.00	80.57	80.57	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	80.58	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	80.55	80.55	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	80.57	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	84.19	84.19	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	84.21	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	84.19	84.19	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	86.12	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	78.69	78.69	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	84.19	8.13	HGL Too High!
P42	DI31	MH22	1.00	64.28	64.28	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	64.36	5.12	HGL Too High!
P43	MH22	DI32	1.00	64.22	64.22	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	64.28	5.45	HGL Too High!
P44	DI32	EX	1.00	63.09	63.09	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	64.22	5.23	HGL Too High!
P46	DI34	DI33	1.00	64.36	64.36	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	64.36	5.47	HGL Too High!
P45	DI33	DI32	1.00	64.22	64.22	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	64.36	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	34.56	34.56	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	34.56	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	79.19	79.19	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	79.41	3.63	HGL Too High!
P48	DI40	DI41	0.80	79.19	79.19	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	79.22	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	78.69	78.69	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	79.19	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	30.97	30.97	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.97	7.41	
P5	MH1	MH2	1.20	30.95	30.95	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	30.97	7.93	HGL Too High!
P7	MH2	MH3	1.20	30.91	30.91	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	30.95	7.65	HGL Too High!
P10	MH3	MH4	1.20	30.83	30.83	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	30.91	7.28	HGL Too High!
P13	MH4	MH5	1.20	30.57	30.57	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	30.83	7.09	HGL Too High!
P15	MH5	MH20	1.60	30.24	30.24	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	30.57	7.40	HGL Too High!
P6	DI16	MH2	1.00	30.95	30.95	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.95	7.33	HGL Too High!
P9	DI3	MH3	1.00	30.91	30.91	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.92	6.62	HGL Too High!
P8	DI17	MH3	1.00	30.91	30.91	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.92	6.96	HGL Too High!
P12	DI4	MH4	1.00	30.83	30.83	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	30.85	6.48	HGL Too High!
P11	DI18	MH4	1.00	30.83	30.83	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.85	6.56	HGL Too High!
P14	DI5	MH5	1.00	30.57	30.57	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.58	6.61	HGL Too High!
P18	DI6	MH6	1.00	30.60	30.60	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	30.63	7.13	HGL Too High!
P16	MH6	MH5	1.20	30.57	30.57	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	30.60	7.55	HGL Too High!
P17	DI19	MH6	1.00	30.60	30.60	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.61	7.08	HGL Too High!
P32	DI23	MH12	1.00	33.24	33.24	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.26	4.24	HGL Too High!
P31	DI9	MH12	1.00	33.24	33.24	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.25	7.13	HGL Too High!
P30	MH12	MH11	1.60	33.22	33.22	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	33.24	7.48	HGL Too High!
P27	MH11	MH10	1.60	33.11	33.11	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	33.22	7.21	HGL Too High!
P25	MH10	MH9	1.60	33.07	33.07	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	33.11	7.54	HGL Too High!
P22	MH9	MH8	1.60	32.99	32.99	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	33.07	7.85	HGL Too High!
P20	MH8	MH21	1.60	32.89	32.89	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	32.99	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	32.82	32.82	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	32.89	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	32.82	32.82	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	32.87	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	32.99	32.99	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	33.02	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	33.28	33.28	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	33.60	4.78	HGL Too High!
P51	STUB	DI22	1.00	33.28	33.28	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	33.33	7.16	HGL Too High!
P28	DI22	MH11	1.00	33.22	33.22	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	33.28	6.74	HGL Too High!
P29	DI8	MH11	1.00	33.22	33.22	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.22	6.92	HGL Too High!
P26	DI21	MH10	1.00	33.11	33.11	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.11	7.23	HGL Too High!
P23	DI20	MH9	1.00	33.07	33.07	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	33.07	7.38	HGL Too High!
P24	DI7	MH9	1.00	33.07	33.07	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.07	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	81.48	81.48	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.48	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	81.48	81.48	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.49	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	81.29	81.29	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	81.48	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	81.05	81.05	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	81.29	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	79.92	79.92	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	81.05	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	79.19	79.19	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	79.92	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	63.59	63.59	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	79.19	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	53.05	53.05	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	63.59	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	35.06	35.06	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	53.05	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	32.82	32.82	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	35.06	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	30.24	30.24	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	32.82	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	29.19	29.19	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	30.24	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	20.94	20.94	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	29.19	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	15.06	15.06	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	20.94	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**12.04**	**12.04**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**15.06**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	83.68	83.68	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	93.64	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	83.68	83.68	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	83.71	6.45	HGL Too High!
P3	DI14	DI13	1.00	83.68	83.68	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	83.69	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	81.29	81.29	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	83.68	6.58	HGL Too High!
P2	DI2	DI1	1.00	81.07	81.07	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.08	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	81.05	81.05	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	81.07	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	84.69	84.69	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	84.71	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	84.69	84.69	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	86.62	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	79.19	79.19	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	84.69	8.13	HGL Too High!
P42	DI31	MH22	1.00	64.78	64.78	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	64.86	5.12	HGL Too High!
P43	MH22	DI32	1.00	64.72	64.72	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	64.78	5.45	HGL Too High!
P44	DI32	EX	1.00	63.59	63.59	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	64.72	5.23	HGL Too High!
P46	DI34	DI33	1.00	64.86	64.86	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	64.86	5.47	HGL Too High!
P45	DI33	DI32	1.00	64.72	64.72	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	64.86	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	35.06	35.06	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	35.06	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	79.69	79.69	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	79.91	3.63	HGL Too High!
P48	DI40	DI41	0.80	79.69	79.69	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	79.72	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	79.19	79.19	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	79.69	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	32.27	32.27	15	0.7	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.27	7.41	
P5	MH1	MH2	1.20	32.25	32.25	18	1.5	0.8	0	82.7	0.0002	0.01	0	0.00	0.00	0.4	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	32.27	7.93	HGL Too High!
P7	MH2	MH3	1.20	32.21	32.21	18	2.2	1.2	1	73.8	0.0004	0.03	0	0.00	0.01	1.3	0.5	0.0	0.8	0.0	0	0.00	0.01	1.0	0.5	0.00	0.03	32.25	7.65	HGL Too High!
P10	MH3	MH4	1.20	32.13	32.13	18	4.0	2.3	8	53.7	0.0012	0.07	0	0.00	0.02	2.8	0.8	0.7	1.2	0.0	1	0.00	0.03	1.0	0.5	0.01	0.08	32.21	7.28	HGL Too High!
P13	MH4	MH5	1.20	31.87	31.87	18	6.9	3.9	84	59.3	0.0036	0.22	0	0.00	0.06	9.1	1.6	1.3	2.3	0.0	8	0.01	0.09	1.0	0.5	0.05	0.26	32.13	7.09	HGL Too High!
P15	MH5	MH20	1.60	31.54	31.54	24	10.3	3.3	90	104	0.0018	0.18	0	0.00	0.04	26.7	3.6	1.1	3.9	0.1	84	0.16	0.28	1.0	0.5	0.14	0.33	31.87	7.40	HGL Too High!
P6	DI16	MH2	1.00	32.25	32.25	15	0.8	0.6	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.25	7.33	HGL Too High!
P9	DI3	MH3	1.00	32.21	32.21	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.22	6.62	HGL Too High!
P8	DI17	MH3	1.00	32.21	32.21	15	0.9	0.7	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.22	6.96	HGL Too High!
P12	DI4	MH4	1.00	32.13	32.13	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	32.15	6.48	HGL Too High!
P11	DI18	MH4	1.00	32.13	32.13	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.15	6.56	HGL Too High!
P14	DI5	MH5	1.00	31.87	31.87	15	1.1	0.9	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.88	6.61	HGL Too High!
P18	DI6	MH6	1.00	31.90	31.90	15	1.5	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.02	31.93	7.13	HGL Too High!
P16	MH6	MH5	1.20	31.87	31.87	18	2.5	1.4	86	40	0.0005	0.02	0	0.00	0.01	1.9	0.9	0.0	1.3	0.0	23	0.01	0.02	1.0	0.5	0.01	0.03	31.90	7.55	HGL Too High!
P17	DI19	MH6	1.00	31.90	31.90	15	1.0	0.8	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.91	7.08	HGL Too High!
P32	DI23	MH12	1.00	34.54	34.54	15	1.2	1.0	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.56	4.24	HGL Too High!
P31	DI9	MH12	1.00	34.54	34.54	15	0.9	0.7	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.55	7.13	HGL Too High!
P30	MH12	MH11	1.60	34.52	34.52	24	2.1	0.7	1	50.1	0.0003	0.02	0	0.00	0.00	0.6	1.2	0.0	1.0	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	34.54	7.48	HGL Too High!
P27	MH11	MH10	1.60	34.41	34.41	24	4.3	1.4	5	73.2	0.0014	0.10	0	0.00	0.01	1.4	1.3	0.8	0.7	0.0	1	0.00	0.01	1.0	0.5	0.00	0.11	34.52	7.21	HGL Too High!
P25	MH10	MH9	1.60	34.37	34.37	24	4.9	1.5	5	69.7	0.0004	0.03	0	0.00	0.01	5.9	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	34.41	7.54	HGL Too High!
P22	MH9	MH8	1.60	34.29	34.29	24	6.1	2.0	51	108	0.0006	0.07	0	0.00	0.01	7.5	0.4	0.3	1.5	0.0	5	0.00	0.03	1.0	0.5	0.02	0.08	34.37	7.85	HGL Too High!
P20	MH8	MH21	1.60	34.19	34.19	24	7.7	2.5	90	57.3	0.0010	0.06	0	0.00	0.02	12.0	2.5	0.0	2.0	0.0	51	0.03	0.07	1.0	0.5	0.04	0.09	34.29	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	34.12	34.12	24	7.7	2.4	21	11.3	0.0010	0.01	0	0.00	0.02	19.0	0.0	0.0	2.5	0.0	90	0.07	0.12	1.0	0.5	0.06	0.07	34.19	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	34.12	34.12	18	5.3	3.0	35	7.75	0.0022	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.05	34.17	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	34.29	34.29	15	1.8	1.4	35	49	0.0006	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	34.32	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	34.58	34.58	8	1.6	4.5	45	17	0.0143	0.24	0	0.00	0.08	0.0	0.0	0.0	0.0	0.0	0	0.00	0.08	1.0	1.0	0.08	0.32	34.90	4.78	HGL Too High!
P51	STUB	DI22	1.00	34.58	34.58	15	3.8	3.1	0	10	0.0029	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	34.63	7.16	HGL Too High!
P28	DI22	MH11	1.00	34.52	34.52	15	1.2	1.0	90	30.3	0.0003	0.01	0	0.00	0.00	11.7	7.0	0.0	3.1	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	34.58	6.74	HGL Too High!
P29	DI8	MH11	1.00	34.52	34.52	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.52	6.92	HGL Too High!
P26	DI21	MH10	1.00	34.41	34.41	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.41	7.23	HGL Too High!
P23	DI20	MH9	1.00	34.37	34.37	15	0.7	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	34.37	7.38	HGL Too High!
P24	DI7	MH9	1.00	34.37	34.37	15	0.7	0.5	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.37	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	82.78	82.78	15	1.1	0.9	90	16	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	82.78	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	82.78	82.78	15	1.2	1.0	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	82.79	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	82.59	82.59	15	2.3	1.9	90	154	0.0011	0.17	0	0.00	0.01	0.9	1.3	0.0	1.0	0.0	90	0.01	0.03	1.0	0.5	0.02	0.18	82.78	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	82.35	82.35	15	5.6	4.6	90	23	0.0076	0.18	0	0.00	0.08	4.3	9.8	0.0	2.8	0.0	0	0.00	0.13	1.0	0.5	0.06	0.24	82.59	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	81.22	81.22	15	6.9	5.6	0	78	0.0115	0.90	0	0.00	0.12	26.0	1.5	0.0	4.6	0.1	90	0.23	0.47	1.0	0.5	0.23	1.13	82.35	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	80.49	80.49	15	6.7	5.5	0	54	0.0109	0.59	0	0.00	0.12	39.1	0.0	0.0	5.6	0.2	0	0.00	0.29	1.0	0.5	0.15	0.73	81.22	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	64.89	64.89	15	15.1	12.3	0	263	0.0549	14.43	0	0.00	0.59	37.0	58.2	15.5	10.3	0.6	90	1.16	2.33	1.0	0.5	1.16	15.60	80.49	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	54.35	54.35	15	20.4	16.6	0	96	0.0999	9.59	0	0.00	1.07	186.6	51.6	0.0	12.3	0.8	0	0.00	1.90	1.0	0.5	0.95	10.54	64.89	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	36.36	36.36	15	20.0	16.3	60	175	0.0956	16.73	0	0.00	1.03	339.7	0.0	0.0	16.6	1.5	0	0.00	2.53	1.0	0.5	1.27	17.99	54.35	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	34.12	34.12	24	19.1	6.1	84	41	0.0072	0.29	0	0.00	0.14	325.0	0.0	0.0	16.3	1.4	60	2.30	3.89	1.0	0.5	1.94	2.24	36.36	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	31.54	31.54	24	29.5	9.4	13	124	0.0170	2.11	0	0.00	0.34	116.6	18.7	16.0	6.1	0.2	84	0.39	0.94	1.0	0.5	0.47	2.58	34.12	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	30.49	30.49	24	37.4	11.9	78	8	0.0274	0.22	0	0.00	0.55	277.0	0.0	0.0	9.4	0.5	13	0.26	1.29	1.3	0.5	0.84	1.06	31.54	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	22.24	22.24	24	37.3	11.9	0	252	0.0272	6.86	0	0.00	0.55	446.2	0.0	0.0	11.9	0.8	78	1.46	2.78	1.0	0.5	1.39	8.24	30.49	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	16.36	16.36	24	34.9	11.1	25	221	0.0238	5.26	0	0.00	0.48	443.2	0.0	0.0	11.9	0.8	0	0.00	1.25	1.0	0.5	0.62	5.88	22.24	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**13.34**	**13.34**	**24**	**33.7**	**10.7**	**0**	**98**	**0.0222**	**2.17**	**0**	**0.00**	**0.45**	**387.8**	**0.0**	**0.0**	**11.1**	**0.7**	**25**	**0.57**	**1.69**	**1.0**	**0.5**	**0.85**	**3.02**	**16.36**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	84.98	84.98	4	1.6	18.0	0	16	0.5832	9.33	0	0.00	1.26	0.0	0.0	0.0	0.0	0.0	0	0.00	1.26	1.0	0.5	0.63	9.96	94.94	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	84.98	84.98	8	0.4	1.2	90	33	0.0008	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	85.01	6.45	HGL Too High!
P3	DI14	DI13	1.00	84.98	84.98	15	0.8	0.6	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	84.99	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	82.59	82.59	15	3.5	2.8	0	15	0.0029	0.04	0	0.00	0.03	0.5	28.4	0.5	18.0	1.8	0	0.00	1.80	1.3	1.0	2.34	2.38	84.98	6.58	HGL Too High!
P2	DI2	DI1	1.00	82.37	82.37	15	0.9	0.7	70	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	82.38	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	100	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	82.35	82.35	15	1.4	1.1	111	3.34	0.0004	0.00	0	0.00	0.00	0.6	0.0	0.0	0.7	0.0	70	0.00	0.01	1.3	1.0	0.02	0.02	82.37	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	85.99	85.99	8	0.3	0.8	104	46	0.0004	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	86.01	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	85.99	85.99	12	5.5	7.0	90	87	0.0200	1.74	0	0.00	0.19	0.0	0.0	0.0	0.0	0.0	0	0.00	0.19	1.0	1.0	0.19	1.93	87.92	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	80.49	80.49	10	5.6	10.3	90	87	0.0563	4.90	0	0.00	0.41	38.0	0.3	0.0	7.0	0.3	90	0.53	1.20	1.0	0.5	0.60	5.50	85.99	8.13	HGL Too High!
P42	DI31	MH22	1.00	66.08	66.08	15	2.3	1.8	7.5	55.8	0.0011	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.07	66.16	5.12	HGL Too High!
P43	MH22	DI32	1.00	66.02	66.02	15	2.3	1.8	80	45.1	0.0010	0.05	0	0.00	0.01	4.2	0.0	0.0	1.8	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	66.08	5.45	HGL Too High!
P44	DI32	EX	1.00	64.89	64.89	15	8.0	6.5	90	59.3	0.0129	0.77	0	0.00	0.16	4.1	8.5	0.0	2.6	0.0	94	0.07	0.28	1.3	1.0	0.36	1.13	66.02	5.23	HGL Too High!
P46	DI34	DI33	1.00	66.16	66.16	15	0.4	0.3	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	66.16	5.47	HGL Too High!
P45	DI33	DI32	1.00	66.02	66.02	15	3.2	2.6	94	48.5	0.0021	0.10	0	0.00	0.03	0.2	0.0	0.0	0.3	0.0	19	0.00	0.03	1.3	1.0	0.04	0.14	66.16	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	36.36	36.36	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	36.36	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	80.99	80.99	12	2.4	3.0	0	47	0.0038	0.18	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.21	81.21	3.63	HGL Too High!
P48	DI40	DI41	0.80	80.99	80.99	12	0.6	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	81.02	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	80.49	80.49	12	3.5	4.4	95	41	0.0082	0.33	0	0.00	0.08	0.5	7.2	0.0	3.0	0.1	0	0.00	0.13	1.3	1.0	0.16	0.50	80.99	4.62	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 200 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
MARKET ST RIVER WEST OUTFALL																										
SOUTH SECTION TO 24"																										
P4	DI15	MH1	3244	1216	4460	0.10	0.93	0.09	0.09	6.0	0.00	8.09	0.8	15	27.3	0.012	0.000120	0.005	4.1	5.0	2.9	0.16	6.16	4.49	4.35	Q ok
P5	MH1	MH2	1	0	1	0.00	1.00	0.00	0.19	6.0	6.16	8.02	1.6	18	82.7	0.012	0.000187	0.005	4.5	8.0	3.4	0.41	6.56	4.25	3.84	Q ok
P7	MH2	MH3	1	0	1	0.00	1.00	0.00	0.29	6.0	6.56	7.88	2.3	18	73.8	0.012	0.000413	0.005	4.6	8.1	3.9	0.32	6.88	3.81	3.44	Q ok
P10	MH3	MH4	1	0	1	0.00	1.00	0.00	0.54	6.0	6.88	7.78	4.2	18	53.7	0.012	0.001355	0.005	4.6	8.1	4.5	0.20	7.08	3.34	3.07	Q ok
P13	MH4	MH5	1	0	1	0.00	1.00	0.00	0.93	6.0	7.08	7.71	7.2	18	59.3	0.012	0.003988	0.005	4.3	7.7	5.0	0.20	7.28	2.97	2.70	Q ok
P15	MH5	MH20	1	0	1	0.00	1.00	0.00	1.41	6.0	7.28	7.64	10.8	24	104.1	0.012	0.001937	0.020	11.1	34.8	9.4	0.18	7.46	2.60	0.50	Q ok
P6	DI16	MH2	3400	1275	4675	0.11	0.93	0.10	0.10	6.0	0.00	8.09	0.8	15	29.3	0.012	0.000132	0.005	4.1	5.0	2.9	0.17	6.17	4.06	3.91	Q ok
P9	DI3	MH3	4110	3259	7369	0.17	0.76	0.13	0.13	6.0	0.00	8.09	1.0	15	18.3	0.012	0.000222	0.005	4.0	4.9	3.0	0.10	6.10	3.68	3.59	Q ok
P8	DI17	MH3	3878	2100	5978	0.14	0.85	0.12	0.12	6.0	0.00	8.09	0.9	15	31.3	0.012	0.000182	0.005	4.2	5.2	3.2	0.17	6.17	3.71	3.54	Q ok
P12	DI4	MH4	7109	2561	9670	0.22	0.93	0.21	0.21	6.0	0.00	6.73	1.4	15	20.1	0.012	0.000396	0.005	4.0	4.9	3.4	0.10	6.10	3.48	3.38	Q ok
P11	DI18	MH4	6435	2210	8645	0.20	0.94	0.19	0.19	6.0	0.00	6.70	1.3	15	28.4	0.012	0.000320	0.005	4.1	5.1	3.4	0.14	6.14	3.48	3.33	Q ok
P14	DI5	MH5	4974	2549	7523	0.17	0.86	0.15	0.15	6.0	0.00	8.09	1.2	15	22.6	0.012	0.000296	0.005	4.0	4.9	3.3	0.11	6.11	3.68	3.57	Q ok
P18	DI6	MH6	6937	1863	8800	0.20	0.98	0.20	0.20	6.0	0.00	8.09	1.6	15	38.0	0.012	0.000528	0.005	4.0	4.9	3.4	0.18	6.18	4.57	4.38	Q ok
P16	MH6	MH5	1	0	1	0.00	1.00	0.00	0.33	6.0	6.18	8.02	2.7	18	40.0	0.012	0.000545	0.011	6.8	12.1	5.1	0.13	6.32	3.77	3.32	Q ok
P17	DI19	MH6	4542	1703	6245	0.14	0.93	0.13	0.13	6.0	0.00	8.09	1.1	15	33.0	0.012	0.000235	0.005	4.0	4.9	3.0	0.18	6.18	4.19	4.02	Q ok
NORTH SECTION TO 24"																										
P32	DI23	MH12	5495	1914	7409	0.17	0.94	0.16	0.16	6.0	0.00	8.09	1.3	15	33.31	0.012	0.0003	0.005	4.1	5.0	3.3	0.17	6.17	3.98	3.81	Q ok
P31	DI9	MH12	4483	551	5034	0.12	1.00	0.12	0.12	6.0	0.00	8.09	0.9	15	18.3	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.86	3.77	Q ok
P30	MH12	MH11	1	0	1	0.00	1.00	0.00	0.28	6.0	6.17	8.02	2.2	18	50.1	0.012	0.0004	0.005	4.5	8.0	3.7	0.22	6.39	3.67	3.42	Q ok
P27	MH11	MH10	1	0	1	0.00	1.00	0.00	0.57	6.0	6.39	7.95	4.5	18	73.2	0.012	0.0016	0.005	4.6	8.1	4.7	0.26	6.65	3.39	3.02	Q ok
P25	MH10	MH9	1	0	1	0.00	1.00	0.00	0.65	6.0	6.65	7.85	5.1	24	69.68	0.012	0.0004	0.006	6.3	19.7	5.1	0.23	6.88	2.92	2.47	Q ok
P22	MH9	MH8	1	0	1	0.00	1.00	0.00	0.83	6.0	6.88	7.78	6.4	24	108.3	0.012	0.0007	0.005	5.5	17.3	5.0	0.36	7.24	2.47	1.93	Q ok
P20	MH8	MH21	1	0	1	0.00	1.00	0.00	1.05	6.0	7.24	7.67	8.1	24	57.3	0.012	0.0011	0.021	11.4	35.8	9.3	0.10	7.34	1.65	0.43	Q ok
P21	MH21	EXMH1	1	0	1	0.00	1.00	0.00	1.05	6.0	7.34	7.64	8.0	24	11.3	0.012	0.0011	0.005	5.7	17.9	5.5	0.03	7.38	0.33	0.27	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 200 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P47	DI35	EXMH1	29988	0	29988	0.69	1.00	0.69	0.69	6.0	0.00	8.09	5.6	18	7.75	0.012	0.0024	0.008	5.8	10.3	5.9	0.02	6.02	-0.50	-0.56	Q ok
P-80	DI-80	MH-08	9967	0	9967	0.23	1.00	0.23	0.23	6.0	0.00	8.09	1.9	15	49	0.012	0.0007	0.009	5.5	6.8	4.5	0.18	6.18	4.53	4.07	Q ok
P52	TDI50	DI22	8815	0	8815	0.20	1.00	0.20	0.20	6.0	0.00	8.09	1.6	8	17	0.012	0.0156	0.010	3.8	1.3	3.1	0.09	6.09	3.92	3.75	Undersized!
P51	STUB	DI22	21322	0	21322	0.49	1.00	0.49	0.49	6.0	0.00	8.09	4.0	15	10.02	0.012	0.0032	0.005	4.0	4.9	4.5	0.04	6.04	3.79	3.74	Q ok
P28	DI22	MH11	5555	1955	7510	0.17	0.94	0.16	0.16	6.0	0.00	8.09	1.3	15	30.3	0.012	0.0003	0.005	4.0	4.9	3.3	0.15	6.15	3.64	3.49	Q ok
P29	DI8	MH11	5120	570	5690	0.13	1.00	0.13	0.13	6.0	0.00	8.09	1.1	15	18.3	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.64	3.55	Q ok
P26	DI21	MH10	2755	930	3685	0.08	0.94	0.08	0.08	6.0	0.00	8.09	0.6	15	18.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.11	6.11	4.02	3.93	Q ok
P23	DI20	MH9	3213	1102	4315	0.10	0.94	0.09	0.09	6.0	0.00	8.09	0.8	15	29.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.17	6.17	4.53	4.38	Q ok
P24	DI7	MH9	3164	527	3691	0.08	1.00	0.08	0.08	6.0	0.00	8.09	0.7	15	28.02	0.012	0.0001	0.005	4.0	4.9	2.8	0.17	6.17	4.38	4.24	Q ok
SOUTH SECTION LOW TRUNK TO 24" OUTFALL																										
CRB-P72	CRB-DI72	CRB-MH-74	6086	0	6086	0.14	1.00	0.14	0.14	6.0	0.00	8.09	1.1	15	16	0.012	0.0003	0.019	7.8	9.6	4.7	0.06	6.06	2.60	2.30	Q ok
CRB-P73	CRB-DI73	CRB-MH-74	7042	0	7042	0.16	1.00	0.16	0.16	6.0	0.00	8.09	1.3	15	34	0.012	0.0003	0.005	4.0	4.9	3.3	0.17	6.17	1.92	1.75	Q ok
CRB-P74	CRB-MH-74	CRB-MH-67	1	0	1	0.00	1.00	0.00	0.30	6.0	6.17	8.02	2.4	15	154	0.012	0.0012	0.005	4.1	5.1	4.1	0.63	6.80	1.65	0.84	Q ok
EXP2	CRB-MH-67	EXMH3	1	0	1	0.00	1.00	0.00	0.76	6.0	6.80	7.81	5.9	15	23	0.013	0.0084	***0.003***	***2.7***	3.3	2.2	0.17	6.97	-1.14	-1.20	Undersized!
EXP3	EXMH3	EXMH4	1	0	1	0.00	1.00	0.00	0.94	6.0	6.97	7.74	7.2	15	78	0.013	0.0126	***0.003***	***2.7***	3.3	2.2	0.59	7.57	-1.20	-1.40	Undersized!
EXP4	EXMH4	EXMH5	1	0	1	0.00	1.00	0.00	0.94	6.0	7.57	7.53	7.0	15	54	0.013	0.0119	***0.003***	***2.7***	3.3	2.2	0.41	7.98	-1.40	-1.54	Undersized!
EXP5	EXMH5	EXMH6	1	0	1	0.00	1.00	0.00	2.14	6.0	7.98	7.39	15.8	15	263	0.013	0.0601	***0.003***	***2.7***	3.3	2.2	2.00	9.97	-1.54	-2.22	Undersized!
EXP6	EXMH6	EXMH7	1	0	1	0.00	1.00	0.00	3.19	6.0	9.97	6.69	21.3	15	96	0.013	0.1092	***0.003***	***2.7***	3.3	2.2	0.73	10.70	-2.22	-2.47	Undersized!
EXP7	EXMH7	EXMH8	1	0	1	0.00	1.00	0.00	3.19	6.0	10.70	6.54	20.9	15	175	0.013	0.1044	***0.003***	***2.7***	3.3	2.2	1.33	12.03	-2.47	-2.92	Undersized!
EXP8	EXMH8	EXMH9	1	0	1	0.00	1.00	0.00	3.19	6.0	12.03	6.27	20.0	24	41	0.013	0.0078	0.009	6.8	21.4	7.9	0.09	12.12	-2.92	-3.29	Q ok
EXP9	EXMH9	EXMH10	1	0	1	0.00	1.00	0.00	4.93	6.0	12.12	6.24	30.8	24	124	0.013	0.0185	0.009	6.8	21.4	5.6	0.37	12.49	-3.29	-4.40	Undersized!
EXP10	EXMH10	EXMH11	1	0	1	0.00	1.00	0.00	6.35	6.0	12.49	6.16	39.1	24	8	0.013	0.0299	***0.001***	***2.7***	8.5	2.2	0.06	12.55	-4.40	-4.41	Undersized!
EXP11	EXMH11	EXMH12	1	0	1	0.00	1.00	0.00	6.35	6.0	12.55	6.16	39.1	24	252	0.013	0.0299	***0.001***	***2.7***	8.5	2.2	1.90	14.45	-4.41	-4.76	Undersized!
EXP12	EXMH12	EXMH13	1	0	1	0.00	1.00	0.00	6.35	6.0	14.45	5.76	36.5	24	221	0.013	0.0261	***0.001***	***2.7***	8.5	2.2	1.67	16.12	-4.76	-5.07	Undersized!
EXP13	**EXMH13**	**OUTFALL**	**1**	**0**	**1**	**0.00**	1.00	**0.00**	**6.35**	**6.0**	**16.12**	5.54	35.1	**24**	**98**	**0.013**	**0.0241**	***0.001***	***2.7***	**8.5**	**2.2**	**0.74**	**16.86**	**-5.07**	**-5.21**	**Undersized!**
ROOF	COLLINS	MSS DI-13	8875	0	8875	0.20	1.00	0.20	0.20	6.0	0.00	8.09	1.6	4	16	0.012	0.6391	0.019	3.2	0.3	2.7	0.10	6.10	2.60	2.30	Undersized!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 200 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
CRB-P75	TD-03	MSS DI-13	2341	0	2341	0.05	1.00	0.05	0.05	6.0	0.00	8.09	**0.43**	8	33	0.011	0.000927	0.0348	7.6	**2.7**	5.3	0.10	6.10	4.57	3.42	Q ok
P3	DI14	DI13	3876	441	4317	0.10	1.00	0.10	0.10	6.0	0.00	8.09	0.8	15	69.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.41	6.41	4.03	3.68	Q ok
EXP1	DI13	MH67	3876	441	4317	0.10	1.00	0.10	0.46	6.0	6.41	7.95	3.6	15	15	0.013	0.0031	***0.003***	***2.7***	3.3	2.2	0.11	6.52	-1.10	-1.14	Undersized!
P2	DI2	DI1	3846	1139	4985	0.11	0.97	0.11	0.11	6.0	0.00	8.09	0.9	15	69.3	0.012	0.0002	0.005	4.0	4.9	3.0	0.38	6.38	4.03	3.68	Q ok
P1	DI1	EXMH	2301	1082	3383	0.08	0.88	0.07	0.18	6.0	6.38	7.95	1.4	15	3.34	0.012	0.0004	0.005	4.0	4.9	3.4	0.02	6.40	3.39	3.37	Q ok
CRB-P84	TD-04	EXMH	1667	0	1667	0.04	1.00	0.04	0.04	6.0	0.00	8.09	**0.31**	8	46	0.011	0.000470	0.0383	8.0	**2.8**	4.8	0.16	6.16	6.26	4.50	Q ok
EXP15	EXDI	EXMH	24757	6130	30887	0.71	1.00	0.71	0.71	6.0	0.00	8.09	**5.72**	12	87	0.012	0.021933	0.0049	3.5	**2.7**	2.8	0.51	6.51	2.00	1.57	Undersized!
EXP16	EXMH	EXMH5	1	0	1	0.00	1.00	0.00	0.74	6.0	6.51	7.92	**5.90**	10	87	0.012	0.061694	0.0049	3.1	**1.7**	2.5	0.58	7.09	2.00	1.57	Undersized!
P42	DI31	MH22	12796.5	0	12797	0.29	1.00	0.29	0.29	6.0	0.00	8.09	2.4	15	55.8	0.012	0.0012	0.005	4.0	5.0	4.0	0.23	6.23	2.00	1.72	Q ok
P43	MH22	DI32	1	0	1	0.00	1.00	0.00	0.29	6.0	6.23	8.02	2.4	15	45.1	0.012	0.0011	0.005	4.1	5.0	4.0	0.19	6.42	1.62	1.39	Q ok
P44	DI32	EX	14459.5	0	14460	0.33	1.00	0.33	1.05	6.0	6.42	7.95	8.3	15	59.3	0.012	0.0142	0.030	9.9	12.1	10.8	0.09	6.51	1.29	0.70	Q ok
P46	DI34	DI33	2420	0	2420	0.06	1.00	0.06	0.06	6.0	0.00	8.09	0.4	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.4	0.26	6.26	2.00	1.82	Q ok
P45	DI33	DI32	15975	0	15975	0.37	1.00	0.37	0.42	6.0	6.26	7.99	3.4	15	48.5	0.012	0.0023	0.007	4.7	5.8	4.9	0.16	6.42	1.72	1.39	Q ok
EXP17	EXMH	EXMH8	1	0	1	0.00	1.00	0.00	0.00	6.0	0.00	8.09	0.0	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.0	0.32	6.32	2.00	1.82	Q ok
EX-P LOT	EXDI LOT	DI-MSS-41	13430	0	13430	0.31	1.00	0.31	0.31	6.0	0.00	8.09	**2.49**	12	47	0.012	0.004176	0.0074	4.2	**3.3**	4.7	0.17	6.17	2.50	2.15	Q ok
P48	DI40	DI41	3590	0	3590	0.08	1.00	0.08	0.08	6.0	0.00	8.09	0.7	12	82.1	0.012	0.0003	0.005	3.5	2.7	2.8	0.48	6.48	2.56	2.15	Q ok
P-MSS-48A	DI-MSS-41	EX-MH LOW	3072	0	3072	0.07	1.00	0.07	0.46	6.0	6.48	7.92	**3.65**	12	41	0.012	0.008947	0.0051	3.5	**2.8**	2.9	0.24	6.72	2.05	1.84	Undersized!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	23.92	23.92	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	23.93	7.41	
P5	MH1	MH2	1.20	23.90	23.90	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	23.92	7.93	HGL Too High!
P7	MH2	MH3	1.20	23.86	23.86	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	23.90	7.65	HGL Too High!
P10	MH3	MH4	1.20	23.78	23.78	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	23.86	7.28	HGL Too High!
P13	MH4	MH5	1.20	23.49	23.49	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	23.78	7.09	HGL Too High!
P15	MH5	MH20	1.60	23.13	23.13	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	23.49	7.40	HGL Too High!
P6	DI16	MH2	1.00	23.90	23.90	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.91	7.33	HGL Too High!
P9	DI3	MH3	1.00	23.86	23.86	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.87	6.62	HGL Too High!
P8	DI17	MH3	1.00	23.86	23.86	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.87	6.96	HGL Too High!
P12	DI4	MH4	1.00	23.78	23.78	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	23.79	6.48	HGL Too High!
P11	DI18	MH4	1.00	23.78	23.78	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.79	6.56	HGL Too High!
P14	DI5	MH5	1.00	23.49	23.49	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.50	6.61	HGL Too High!
P18	DI6	MH6	1.00	23.52	23.52	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	23.55	7.13	HGL Too High!
P16	MH6	MH5	1.20	23.49	23.49	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	23.52	7.55	HGL Too High!
P17	DI19	MH6	1.00	23.52	23.52	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.53	7.08	HGL Too High!
P32	DI23	MH12	1.00	26.40	26.40	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	26.42	4.24	HGL Too High!
P31	DI9	MH12	1.00	26.40	26.40	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.41	7.13	HGL Too High!
P30	MH12	MH11	1.60	26.38	26.38	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	26.40	7.48	HGL Too High!
P27	MH11	MH10	1.60	26.26	26.26	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	26.38	7.21	HGL Too High!
P25	MH10	MH9	1.60	26.21	26.21	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	26.26	7.54	HGL Too High!
P22	MH9	MH8	1.60	26.12	26.12	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	26.21	7.85	HGL Too High!
P20	MH8	MH21	1.60	26.02	26.02	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	26.12	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	25.94	25.94	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	26.02	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	25.94	25.94	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	26.00	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	26.12	26.12	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	26.17	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	26.45	26.45	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	26.80	4.78	HGL Too High!
P51	STUB	DI22	1.00	26.45	26.45	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	26.50	7.16	HGL Too High!
P28	DI22	MH11	1.00	26.38	26.38	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	26.45	6.74	HGL Too High!
P29	DI8	MH11	1.00	26.38	26.38	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.38	6.92	HGL Too High!
P26	DI21	MH10	1.00	26.26	26.26	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.26	7.23	HGL Too High!
P23	DI20	MH9	1.00	26.21	26.21	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	26.22	7.38	HGL Too High!
P24	DI7	MH9	1.00	26.21	26.21	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.22	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	79.13	79.13	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	79.14	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	79.13	79.13	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	79.14	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	78.93	78.93	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	79.13	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	78.67	78.67	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	78.93	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	77.43	77.43	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	78.67	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	76.63	76.63	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	77.43	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	59.55	59.55	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	76.63	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	48.03	48.03	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	59.55	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	28.38	28.38	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	48.03	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	25.94	25.94	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	28.38	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	23.13	23.13	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	25.94	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	21.98	21.98	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	23.13	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	12.94	12.94	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	21.98	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	6.49	6.49	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	12.94	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.20**	**3.20**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**6.49**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	81.54	81.54	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	92.46	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	81.54	81.54	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	81.58	6.45	HGL Too High!
P3	DI14	DI13	1.00	81.54	81.54	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.55	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	78.93	78.93	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	81.54	6.58	HGL Too High!
P2	DI2	DI1	1.00	78.68	78.68	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.70	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	____ of ____
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	78.67	78.67	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	78.68	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	82.65	82.65	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	82.68	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	82.65	82.65	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	84.77	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	76.63	76.63	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	82.65	8.13	HGL Too High!
P42	DI31	MH22	1.00	60.86	60.86	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	60.94	5.12	HGL Too High!
P43	MH22	DI32	1.00	60.79	60.79	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	60.86	5.45	HGL Too High!
P44	DI32	EX	1.00	59.55	59.55	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	60.79	5.23	HGL Too High!
P46	DI34	DI33	1.00	60.94	60.94	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	60.94	5.47	HGL Too High!
P45	DI33	DI32	1.00	60.79	60.79	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	60.94	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	28.38	28.38	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	28.38	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	77.17	77.17	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	77.41	3.63	HGL Too High!
P48	DI40	DI41	0.80	77.17	77.17	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	77.20	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	76.63	76.63	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	77.17	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	24.12	24.12	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	24.13	7.41	
P5	MH1	MH2	1.20	24.10	24.10	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	24.12	7.93	HGL Too High!
P7	MH2	MH3	1.20	24.06	24.06	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	24.10	7.65	HGL Too High!
P10	MH3	MH4	1.20	23.98	23.98	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	24.06	7.28	HGL Too High!
P13	MH4	MH5	1.20	23.69	23.69	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	23.98	7.09	HGL Too High!
P15	MH5	MH20	1.60	23.33	23.33	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	23.69	7.40	HGL Too High!
P6	DI16	MH2	1.00	24.10	24.10	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.11	7.33	HGL Too High!
P9	DI3	MH3	1.00	24.06	24.06	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.07	6.62	HGL Too High!
P8	DI17	MH3	1.00	24.06	24.06	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	24.07	6.96	HGL Too High!
P12	DI4	MH4	1.00	23.98	23.98	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	23.99	6.48	HGL Too High!
P11	DI18	MH4	1.00	23.98	23.98	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.99	6.56	HGL Too High!
P14	DI5	MH5	1.00	23.69	23.69	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.70	6.61	HGL Too High!
P18	DI6	MH6	1.00	23.72	23.72	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	23.75	7.13	HGL Too High!
P16	MH6	MH5	1.20	23.69	23.69	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	23.72	7.55	HGL Too High!
P17	DI19	MH6	1.00	23.72	23.72	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	23.73	7.08	HGL Too High!
P32	DI23	MH12	1.00	26.60	26.60	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	26.62	4.24	HGL Too High!
P31	DI9	MH12	1.00	26.60	26.60	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.61	7.13	HGL Too High!
P30	MH12	MH11	1.60	26.58	26.58	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	26.60	7.48	HGL Too High!
P27	MH11	MH10	1.60	26.46	26.46	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	26.58	7.21	HGL Too High!
P25	MH10	MH9	1.60	26.41	26.41	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	26.46	7.54	HGL Too High!
P22	MH9	MH8	1.60	26.32	26.32	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	26.41	7.85	HGL Too High!
P20	MH8	MH21	1.60	26.22	26.22	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	26.32	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	26.14	26.14	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	26.22	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	26.14	26.14	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	26.20	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	26.32	26.32	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	26.37	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	26.65	26.65	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	27.00	4.78	HGL Too High!
P51	STUB	DI22	1.00	26.65	26.65	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	26.70	7.16	HGL Too High!
P28	DI22	MH11	1.00	26.58	26.58	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	26.65	6.74	HGL Too High!
P29	DI8	MH11	1.00	26.58	26.58	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.58	6.92	HGL Too High!
P26	DI21	MH10	1.00	26.46	26.46	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.46	7.23	HGL Too High!
P23	DI20	MH9	1.00	26.41	26.41	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	26.42	7.38	HGL Too High!
P24	DI7	MH9	1.00	26.41	26.41	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.42	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	79.33	79.33	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	79.34	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	79.33	79.33	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	79.34	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	79.13	79.13	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	79.33	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	78.87	78.87	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	79.13	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	77.63	77.63	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	78.87	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	76.83	76.83	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	77.63	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	59.75	59.75	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	76.83	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	48.23	48.23	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	59.75	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	28.58	28.58	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	48.23	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	26.14	26.14	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	28.58	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	23.33	23.33	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	26.14	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	22.18	22.18	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	23.33	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.14	13.14	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	22.18	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	6.69	6.69	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	13.14	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.40**	**3.40**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**6.69**	**7.80**	**HGL ok**
ROOF	COLLINS	MSS DI-13	0.27	81.74	81.74	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	92.66	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	81.74	81.74	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	81.78	6.45	HGL Too High!
P3	DI14	DI13	1.00	81.74	81.74	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.75	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	79.13	79.13	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	81.74	6.58	HGL Too High!
P2	DI2	DI1	1.00	78.88	78.88	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	78.90	6.84	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	78.87	78.87	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	78.88	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	82.85	82.85	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	82.88	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	82.85	82.85	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	84.97	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	76.83	76.83	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	82.85	8.13	HGL Too High!
P42	DI31	MH22	1.00	61.06	61.06	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	61.14	5.12	HGL Too High!
P43	MH22	DI32	1.00	60.99	60.99	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	61.06	5.45	HGL Too High!
P44	DI32	EX	1.00	59.75	59.75	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	60.99	5.23	HGL Too High!
P46	DI34	DI33	1.00	61.14	61.14	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	61.14	5.47	HGL Too High!
P45	DI33	DI32	1.00	60.99	60.99	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	61.14	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	28.58	28.58	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	28.58	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	77.37	77.37	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	77.61	3.63	HGL Too High!
P48	DI40	DI41	0.80	77.37	77.37	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	77.40	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	76.83	76.83	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	77.37	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	27.62	27.62	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	27.63	7.41	
P5	MH1	MH2	1.20	27.60	27.60	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	27.62	7.93	HGL Too High!
P7	MH2	MH3	1.20	27.56	27.56	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	27.60	7.65	HGL Too High!
P10	MH3	MH4	1.20	27.48	27.48	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	27.56	7.28	HGL Too High!
P13	MH4	MH5	1.20	27.19	27.19	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	27.48	7.09	HGL Too High!
P15	MH5	MH20	1.60	26.83	26.83	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	27.19	7.40	HGL Too High!
P6	DI16	MH2	1.00	27.60	27.60	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.61	7.33	HGL Too High!
P9	DI3	MH3	1.00	27.56	27.56	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.57	6.62	HGL Too High!
P8	DI17	MH3	1.00	27.56	27.56	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.57	6.96	HGL Too High!
P12	DI4	MH4	1.00	27.48	27.48	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	27.49	6.48	HGL Too High!
P11	DI18	MH4	1.00	27.48	27.48	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.49	6.56	HGL Too High!
P14	DI5	MH5	1.00	27.19	27.19	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.20	6.61	HGL Too High!
P18	DI6	MH6	1.00	27.22	27.22	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	27.25	7.13	HGL Too High!
P16	MH6	MH5	1.20	27.19	27.19	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	27.22	7.55	HGL Too High!
P17	DI19	MH6	1.00	27.22	27.22	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.23	7.08	HGL Too High!
P32	DI23	MH12	1.00	30.10	30.10	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	30.12	4.24	HGL Too High!
P31	DI9	MH12	1.00	30.10	30.10	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.11	7.13	HGL Too High!
P30	MH12	MH11	1.60	30.08	30.08	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	30.10	7.48	HGL Too High!
P27	MH11	MH10	1.60	29.96	29.96	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	30.08	7.21	HGL Too High!
P25	MH10	MH9	1.60	29.91	29.91	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	29.96	7.54	HGL Too High!
P22	MH9	MH8	1.60	29.82	29.82	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	29.91	7.85	HGL Too High!
P20	MH8	MH21	1.60	29.72	29.72	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	29.82	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	29.64	29.64	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	29.72	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	29.64	29.64	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	29.70	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	29.82	29.82	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	29.87	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	30.15	30.15	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	30.50	4.78	HGL Too High!
P51	STUB	DI22	1.00	30.15	30.15	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	30.20	7.16	HGL Too High!
P28	DI22	MH11	1.00	30.08	30.08	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	30.15	6.74	HGL Too High!
P29	DI8	MH11	1.00	30.08	30.08	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.08	6.92	HGL Too High!
P26	DI21	MH10	1.00	29.96	29.96	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.96	7.23	HGL Too High!
P23	DI20	MH9	1.00	29.91	29.91	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	29.92	7.38	HGL Too High!
P24	DI7	MH9	1.00	29.91	29.91	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.92	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	82.83	82.83	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	82.84	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	82.83	82.83	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	82.84	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	82.63	82.63	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	82.83	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	82.37	82.37	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	82.63	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	81.13	81.13	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	82.37	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	80.33	80.33	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	81.13	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	63.25	63.25	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	80.33	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	51.73	51.73	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	63.25	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	32.08	32.08	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	51.73	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	29.64	29.64	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	32.08	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	26.83	26.83	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	29.64	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	25.68	25.68	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	26.83	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	16.64	16.64	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	25.68	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.19	10.19	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	16.64	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**6.90**	**6.90**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**10.19**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	85.24	85.24	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	96.16	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	85.24	85.24	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	85.28	6.45	HGL Too High!
P3	DI14	DI13	1.00	85.24	85.24	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	85.25	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	82.63	82.63	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	85.24	6.58	HGL Too High!
P2	DI2	DI1	1.00	82.38	82.38	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	82.40	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	82.37	82.37	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	82.38	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	86.35	86.35	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	86.38	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	86.35	86.35	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	88.47	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	80.33	80.33	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	86.35	8.13	HGL Too High!
P42	DI31	MH22	1.00	64.56	64.56	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	64.64	5.12	HGL Too High!
P43	MH22	DI32	1.00	64.49	64.49	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	64.56	5.45	HGL Too High!
P44	DI32	EX	1.00	63.25	63.25	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	64.49	5.23	HGL Too High!
P46	DI34	DI33	1.00	64.64	64.64	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	64.64	5.47	HGL Too High!
P45	DI33	DI32	1.00	64.49	64.49	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	64.64	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	32.08	32.08	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	32.08	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	80.87	80.87	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	81.11	3.63	HGL Too High!
P48	DI40	DI41	0.80	80.87	80.87	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	80.90	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	80.33	80.33	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	80.87	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	28.12	28.12	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.13	7.41	
P5	MH1	MH2	1.20	28.10	28.10	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	28.12	7.93	HGL Too High!
P7	MH2	MH3	1.20	28.06	28.06	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	28.10	7.65	HGL Too High!
P10	MH3	MH4	1.20	27.98	27.98	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	28.06	7.28	HGL Too High!
P13	MH4	MH5	1.20	27.69	27.69	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	27.98	7.09	HGL Too High!
P15	MH5	MH20	1.60	27.33	27.33	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	27.69	7.40	HGL Too High!
P6	DI16	MH2	1.00	28.10	28.10	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.11	7.33	HGL Too High!
P9	DI3	MH3	1.00	28.06	28.06	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.07	6.62	HGL Too High!
P8	DI17	MH3	1.00	28.06	28.06	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.07	6.96	HGL Too High!
P12	DI4	MH4	1.00	27.98	27.98	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	27.99	6.48	HGL Too High!
P11	DI18	MH4	1.00	27.98	27.98	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.99	6.56	HGL Too High!
P14	DI5	MH5	1.00	27.69	27.69	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.70	6.61	HGL Too High!
P18	DI6	MH6	1.00	27.72	27.72	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	27.75	7.13	HGL Too High!
P16	MH6	MH5	1.20	27.69	27.69	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	27.72	7.55	HGL Too High!
P17	DI19	MH6	1.00	27.72	27.72	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	27.73	7.08	HGL Too High!
P32	DI23	MH12	1.00	30.60	30.60	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	30.62	4.24	HGL Too High!
P31	DI9	MH12	1.00	30.60	30.60	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.61	7.13	HGL Too High!
P30	MH12	MH11	1.60	30.58	30.58	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	30.60	7.48	HGL Too High!
P27	MH11	MH10	1.60	30.46	30.46	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	30.58	7.21	HGL Too High!
P25	MH10	MH9	1.60	30.41	30.41	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	30.46	7.54	HGL Too High!
P22	MH9	MH8	1.60	30.32	30.32	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	30.41	7.85	HGL Too High!
P20	MH8	MH21	1.60	30.22	30.22	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	30.32	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	30.14	30.14	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	30.22	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	30.14	30.14	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	30.20	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	30.32	30.32	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	30.37	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	30.65	30.65	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	31.00	4.78	HGL Too High!
P51	STUB	DI22	1.00	30.65	30.65	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	30.70	7.16	HGL Too High!
P28	DI22	MH11	1.00	30.58	30.58	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	30.65	6.74	HGL Too High!
P29	DI8	MH11	1.00	30.58	30.58	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.58	6.92	HGL Too High!
P26	DI21	MH10	1.00	30.46	30.46	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.46	7.23	HGL Too High!
P23	DI20	MH9	1.00	30.41	30.41	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	30.42	7.38	HGL Too High!
P24	DI7	MH9	1.00	30.41	30.41	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.42	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	83.33	83.33	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	83.34	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	83.33	83.33	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	83.34	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	83.13	83.13	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	83.33	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	82.87	82.87	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	83.13	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	81.63	81.63	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	82.87	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	80.83	80.83	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	81.63	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	63.75	63.75	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	80.83	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	52.23	52.23	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	63.75	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	32.58	32.58	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	52.23	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	30.14	30.14	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	32.58	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	27.33	27.33	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	30.14	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	26.18	26.18	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	27.33	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	17.14	17.14	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	26.18	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.69	10.69	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	17.14	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.40**	**7.40**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**10.69**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	85.74	85.74	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	96.66	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	85.74	85.74	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	85.78	6.45	HGL Too High!
P3	DI14	DI13	1.00	85.74	85.74	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	85.75	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	83.13	83.13	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	85.74	6.58	HGL Too High!
P2	DI2	DI1	1.00	82.88	82.88	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	82.90	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	82.87	82.87	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	82.88	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	86.85	86.85	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	86.88	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	86.85	86.85	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	88.97	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	80.83	80.83	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	86.85	8.13	HGL Too High!
P42	DI31	MH22	1.00	65.06	65.06	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	65.14	5.12	HGL Too High!
P43	MH22	DI32	1.00	64.99	64.99	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	65.06	5.45	HGL Too High!
P44	DI32	EX	1.00	63.75	63.75	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	64.99	5.23	HGL Too High!
P46	DI34	DI33	1.00	65.14	65.14	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	65.14	5.47	HGL Too High!
P45	DI33	DI32	1.00	64.99	64.99	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	65.14	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	32.58	32.58	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	32.58	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	81.37	81.37	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	81.61	3.63	HGL Too High!
P48	DI40	DI41	0.80	81.37	81.37	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	81.40	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	80.83	80.83	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	81.37	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	28.52	28.52	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.53	7.41	
P5	MH1	MH2	1.20	28.50	28.50	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	28.52	7.93	HGL Too High!
P7	MH2	MH3	1.20	28.46	28.46	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	28.50	7.65	HGL Too High!
P10	MH3	MH4	1.20	28.38	28.38	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	28.46	7.28	HGL Too High!
P13	MH4	MH5	1.20	28.09	28.09	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	28.38	7.09	HGL Too High!
P15	MH5	MH20	1.60	27.73	27.73	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	28.09	7.40	HGL Too High!
P6	DI16	MH2	1.00	28.50	28.50	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.51	7.33	HGL Too High!
P9	DI3	MH3	1.00	28.46	28.46	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.47	6.62	HGL Too High!
P8	DI17	MH3	1.00	28.46	28.46	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.47	6.96	HGL Too High!
P12	DI4	MH4	1.00	28.38	28.38	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	28.39	6.48	HGL Too High!
P11	DI18	MH4	1.00	28.38	28.38	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.39	6.56	HGL Too High!
P14	DI5	MH5	1.00	28.09	28.09	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.10	6.61	HGL Too High!
P18	DI6	MH6	1.00	28.12	28.12	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	28.15	7.13	HGL Too High!
P16	MH6	MH5	1.20	28.09	28.09	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	28.12	7.55	HGL Too High!
P17	DI19	MH6	1.00	28.12	28.12	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.13	7.08	HGL Too High!
P32	DI23	MH12	1.00	31.00	31.00	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	31.02	4.24	HGL Too High!
P31	DI9	MH12	1.00	31.00	31.00	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.01	7.13	HGL Too High!
P30	MH12	MH11	1.60	30.98	30.98	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	31.00	7.48	HGL Too High!
P27	MH11	MH10	1.60	30.86	30.86	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	30.98	7.21	HGL Too High!
P25	MH10	MH9	1.60	30.81	30.81	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	30.86	7.54	HGL Too High!
P22	MH9	MH8	1.60	30.72	30.72	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	30.81	7.85	HGL Too High!
P20	MH8	MH21	1.60	30.62	30.62	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	30.72	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	30.54	30.54	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	30.62	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	30.54	30.54	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	30.60	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	30.72	30.72	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	30.77	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	31.05	31.05	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	31.40	4.78	HGL Too High!
P51	STUB	DI22	1.00	31.05	31.05	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	31.10	7.16	HGL Too High!
P28	DI22	MH11	1.00	30.98	30.98	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	31.05	6.74	HGL Too High!
P29	DI8	MH11	1.00	30.98	30.98	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.98	6.92	HGL Too High!
P26	DI21	MH10	1.00	30.86	30.86	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.86	7.23	HGL Too High!
P23	DI20	MH9	1.00	30.81	30.81	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	30.82	7.38	HGL Too High!
P24	DI7	MH9	1.00	30.81	30.81	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.82	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	83.73	83.73	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	83.74	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	83.73	83.73	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	83.74	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	83.53	83.53	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	83.73	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	83.27	83.27	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	83.53	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	82.03	82.03	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	83.27	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	81.23	81.23	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	82.03	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	64.15	64.15	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	81.23	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	52.63	52.63	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	64.15	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	32.98	32.98	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	52.63	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	30.54	30.54	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	32.98	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	27.73	27.73	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	30.54	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	26.58	26.58	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	27.73	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	17.54	17.54	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	26.58	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.09	11.09	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	17.54	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.80**	**7.80**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**11.09**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	86.14	86.14	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	97.06	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	86.14	86.14	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	86.18	6.45	HGL Too High!
P3	DI14	DI13	1.00	86.14	86.14	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	86.15	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	83.53	83.53	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	86.14	6.58	HGL Too High!
P2	DI2	DI1	1.00	83.28	83.28	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	83.30	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	83.27	83.27	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	83.28	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	87.25	87.25	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	87.28	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	87.25	87.25	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	89.37	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	81.23	81.23	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	87.25	8.13	HGL Too High!
P42	DI31	MH22	1.00	65.46	65.46	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	65.54	5.12	HGL Too High!
P43	MH22	DI32	1.00	65.39	65.39	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	65.46	5.45	HGL Too High!
P44	DI32	EX	1.00	64.15	64.15	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	65.39	5.23	HGL Too High!
P46	DI34	DI33	1.00	65.54	65.54	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	65.54	5.47	HGL Too High!
P45	DI33	DI32	1.00	65.39	65.39	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	65.54	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	32.98	32.98	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	32.98	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	81.77	81.77	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	82.01	3.63	HGL Too High!
P48	DI40	DI41	0.80	81.77	81.77	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	81.80	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	81.23	81.23	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	81.77	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	29.02	29.02	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.03	7.41	
P5	MH1	MH2	1.20	29.00	29.00	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	29.02	7.93	HGL Too High!
P7	MH2	MH3	1.20	28.96	28.96	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	29.00	7.65	HGL Too High!
P10	MH3	MH4	1.20	28.88	28.88	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	28.96	7.28	HGL Too High!
P13	MH4	MH5	1.20	28.59	28.59	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	28.88	7.09	HGL Too High!
P15	MH5	MH20	1.60	28.23	28.23	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	28.59	7.40	HGL Too High!
P6	DI16	MH2	1.00	29.00	29.00	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.01	7.33	HGL Too High!
P9	DI3	MH3	1.00	28.96	28.96	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.97	6.62	HGL Too High!
P8	DI17	MH3	1.00	28.96	28.96	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.97	6.96	HGL Too High!
P12	DI4	MH4	1.00	28.88	28.88	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	28.89	6.48	HGL Too High!
P11	DI18	MH4	1.00	28.88	28.88	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.89	6.56	HGL Too High!
P14	DI5	MH5	1.00	28.59	28.59	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.60	6.61	HGL Too High!
P18	DI6	MH6	1.00	28.62	28.62	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	28.65	7.13	HGL Too High!
P16	MH6	MH5	1.20	28.59	28.59	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	28.62	7.55	HGL Too High!
P17	DI19	MH6	1.00	28.62	28.62	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.63	7.08	HGL Too High!
P32	DI23	MH12	1.00	31.50	31.50	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	31.52	4.24	HGL Too High!
P31	DI9	MH12	1.00	31.50	31.50	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.51	7.13	HGL Too High!
P30	MH12	MH11	1.60	31.48	31.48	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	31.50	7.48	HGL Too High!
P27	MH11	MH10	1.60	31.36	31.36	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	31.48	7.21	HGL Too High!
P25	MH10	MH9	1.60	31.31	31.31	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	31.36	7.54	HGL Too High!
P22	MH9	MH8	1.60	31.22	31.22	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	31.31	7.85	HGL Too High!
P20	MH8	MH21	1.60	31.12	31.12	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	31.22	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	31.04	31.04	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	31.12	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	31.04	31.04	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	31.10	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	31.22	31.22	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	31.27	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	31.55	31.55	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	31.90	4.78	HGL Too High!
P51	STUB	DI22	1.00	31.55	31.55	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	31.60	7.16	HGL Too High!
P28	DI22	MH11	1.00	31.48	31.48	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	31.55	6.74	HGL Too High!
P29	DI8	MH11	1.00	31.48	31.48	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.48	6.92	HGL Too High!
P26	DI21	MH10	1.00	31.36	31.36	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.36	7.23	HGL Too High!
P23	DI20	MH9	1.00	31.31	31.31	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	31.32	7.38	HGL Too High!
P24	DI7	MH9	1.00	31.31	31.31	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.32	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	84.23	84.23	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	84.24	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	84.23	84.23	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	84.24	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	84.03	84.03	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	84.23	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	83.77	83.77	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	84.03	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	82.53	82.53	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	83.77	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	81.73	81.73	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	82.53	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	64.65	64.65	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	81.73	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	53.13	53.13	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	64.65	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	33.48	33.48	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	53.13	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	31.04	31.04	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	33.48	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	28.23	28.23	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	31.04	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	27.08	27.08	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	28.23	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	18.04	18.04	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	27.08	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.59	11.59	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	18.04	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**8.30**	**8.30**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**11.59**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	86.64	86.64	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	97.56	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	86.64	86.64	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	86.68	6.45	HGL Too High!
P3	DI14	DI13	1.00	86.64	86.64	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	86.65	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	84.03	84.03	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	86.64	6.58	HGL Too High!
P2	DI2	DI1	1.00	83.78	83.78	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	83.80	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	83.77	83.77	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	83.78	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	87.75	87.75	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	87.78	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	87.75	87.75	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	89.87	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	81.73	81.73	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	87.75	8.13	HGL Too High!
P42	DI31	MH22	1.00	65.96	65.96	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	66.04	5.12	HGL Too High!
P43	MH22	DI32	1.00	65.89	65.89	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	65.96	5.45	HGL Too High!
P44	DI32	EX	1.00	64.65	64.65	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	65.89	5.23	HGL Too High!
P46	DI34	DI33	1.00	66.04	66.04	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	66.04	5.47	HGL Too High!
P45	DI33	DI32	1.00	65.89	65.89	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	66.04	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	33.48	33.48	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	33.48	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	82.27	82.27	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	82.51	3.63	HGL Too High!
P48	DI40	DI41	0.80	82.27	82.27	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	82.30	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	81.73	81.73	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	82.27	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	29.72	29.72	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.73	7.41	
P5	MH1	MH2	1.20	29.70	29.70	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	29.72	7.93	HGL Too High!
P7	MH2	MH3	1.20	29.66	29.66	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	29.70	7.65	HGL Too High!
P10	MH3	MH4	1.20	29.58	29.58	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	29.66	7.28	HGL Too High!
P13	MH4	MH5	1.20	29.29	29.29	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	29.58	7.09	HGL Too High!
P15	MH5	MH20	1.60	28.93	28.93	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	29.29	7.40	HGL Too High!
P6	DI16	MH2	1.00	29.70	29.70	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.71	7.33	HGL Too High!
P9	DI3	MH3	1.00	29.66	29.66	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.67	6.62	HGL Too High!
P8	DI17	MH3	1.00	29.66	29.66	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.67	6.96	HGL Too High!
P12	DI4	MH4	1.00	29.58	29.58	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	29.59	6.48	HGL Too High!
P11	DI18	MH4	1.00	29.58	29.58	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.59	6.56	HGL Too High!
P14	DI5	MH5	1.00	29.29	29.29	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.30	6.61	HGL Too High!
P18	DI6	MH6	1.00	29.32	29.32	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	29.35	7.13	HGL Too High!
P16	MH6	MH5	1.20	29.29	29.29	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	29.32	7.55	HGL Too High!
P17	DI19	MH6	1.00	29.32	29.32	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.33	7.08	HGL Too High!
P32	DI23	MH12	1.00	32.20	32.20	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	32.22	4.24	HGL Too High!
P31	DI9	MH12	1.00	32.20	32.20	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.21	7.13	HGL Too High!
P30	MH12	MH11	1.60	32.18	32.18	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	32.20	7.48	HGL Too High!
P27	MH11	MH10	1.60	32.06	32.06	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	32.18	7.21	HGL Too High!
P25	MH10	MH9	1.60	32.01	32.01	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	32.06	7.54	HGL Too High!
P22	MH9	MH8	1.60	31.92	31.92	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	32.01	7.85	HGL Too High!
P20	MH8	MH21	1.60	31.82	31.82	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	31.92	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	31.74	31.74	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	31.82	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	31.74	31.74	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	31.80	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	31.92	31.92	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	31.97	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	32.25	32.25	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	32.60	4.78	HGL Too High!
P51	STUB	DI22	1.00	32.25	32.25	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	32.30	7.16	HGL Too High!
P28	DI22	MH11	1.00	32.18	32.18	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	32.25	6.74	HGL Too High!
P29	DI8	MH11	1.00	32.18	32.18	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.18	6.92	HGL Too High!
P26	DI21	MH10	1.00	32.06	32.06	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.06	7.23	HGL Too High!
P23	DI20	MH9	1.00	32.01	32.01	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	32.02	7.38	HGL Too High!
P24	DI7	MH9	1.00	32.01	32.01	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.02	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	84.93	84.93	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	84.94	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	84.93	84.93	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	84.94	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	84.73	84.73	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	84.93	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	84.47	84.47	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	84.73	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	83.23	83.23	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	84.47	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	82.43	82.43	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	83.23	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	65.35	65.35	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	82.43	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	53.83	53.83	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	65.35	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	34.18	34.18	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	53.83	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	31.74	31.74	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	34.18	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	28.93	28.93	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	31.74	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	27.78	27.78	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	28.93	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	18.74	18.74	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	27.78	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.29	12.29	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	18.74	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.00**	**9.00**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**12.29**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	87.34	87.34	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	98.26	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	87.34	87.34	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	87.38	6.45	HGL Too High!
P3	DI14	DI13	1.00	87.34	87.34	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	87.35	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	84.73	84.73	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	87.34	6.58	HGL Too High!
P2	DI2	DI1	1.00	84.48	84.48	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	84.50	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	84.47	84.47	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	84.48	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	88.45	88.45	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	88.48	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	88.45	88.45	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	90.57	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	82.43	82.43	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	88.45	8.13	HGL Too High!
P42	DI31	MH22	1.00	66.66	66.66	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	66.74	5.12	HGL Too High!
P43	MH22	DI32	1.00	66.59	66.59	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	66.66	5.45	HGL Too High!
P44	DI32	EX	1.00	65.35	65.35	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	66.59	5.23	HGL Too High!
P46	DI34	DI33	1.00	66.74	66.74	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	66.74	5.47	HGL Too High!
P45	DI33	DI32	1.00	66.59	66.59	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	66.74	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	34.18	34.18	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	34.18	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	82.97	82.97	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	83.21	3.63	HGL Too High!
P48	DI40	DI41	0.80	82.97	82.97	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	83.00	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	82.43	82.43	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	82.97	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	30.22	30.22	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.23	7.41	
P5	MH1	MH2	1.20	30.20	30.20	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	30.22	7.93	HGL Too High!
P7	MH2	MH3	1.20	30.16	30.16	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	30.20	7.65	HGL Too High!
P10	MH3	MH4	1.20	30.08	30.08	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	30.16	7.28	HGL Too High!
P13	MH4	MH5	1.20	29.79	29.79	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	30.08	7.09	HGL Too High!
P15	MH5	MH20	1.60	29.43	29.43	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	29.79	7.40	HGL Too High!
P6	DI16	MH2	1.00	30.20	30.20	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.21	7.33	HGL Too High!
P9	DI3	MH3	1.00	30.16	30.16	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.17	6.62	HGL Too High!
P8	DI17	MH3	1.00	30.16	30.16	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.17	6.96	HGL Too High!
P12	DI4	MH4	1.00	30.08	30.08	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	30.09	6.48	HGL Too High!
P11	DI18	MH4	1.00	30.08	30.08	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.09	6.56	HGL Too High!
P14	DI5	MH5	1.00	29.79	29.79	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.80	6.61	HGL Too High!
P18	DI6	MH6	1.00	29.82	29.82	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	29.85	7.13	HGL Too High!
P16	MH6	MH5	1.20	29.79	29.79	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	29.82	7.55	HGL Too High!
P17	DI19	MH6	1.00	29.82	29.82	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.83	7.08	HGL Too High!
P32	DI23	MH12	1.00	32.70	32.70	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	32.72	4.24	HGL Too High!
P31	DI9	MH12	1.00	32.70	32.70	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.71	7.13	HGL Too High!
P30	MH12	MH11	1.60	32.68	32.68	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	32.70	7.48	HGL Too High!
P27	MH11	MH10	1.60	32.56	32.56	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	32.68	7.21	HGL Too High!
P25	MH10	MH9	1.60	32.51	32.51	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	32.56	7.54	HGL Too High!
P22	MH9	MH8	1.60	32.42	32.42	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	32.51	7.85	HGL Too High!
P20	MH8	MH21	1.60	32.32	32.32	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	32.42	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	32.24	32.24	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	32.32	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	32.24	32.24	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	32.30	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	32.42	32.42	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	32.47	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	32.75	32.75	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	33.10	4.78	HGL Too High!
P51	STUB	DI22	1.00	32.75	32.75	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	32.80	7.16	HGL Too High!
P28	DI22	MH11	1.00	32.68	32.68	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	32.75	6.74	HGL Too High!
P29	DI8	MH11	1.00	32.68	32.68	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.68	6.92	HGL Too High!
P26	DI21	MH10	1.00	32.56	32.56	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.56	7.23	HGL Too High!
P23	DI20	MH9	1.00	32.51	32.51	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	32.52	7.38	HGL Too High!
P24	DI7	MH9	1.00	32.51	32.51	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.52	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	85.43	85.43	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	85.44	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	85.43	85.43	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	85.44	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	85.23	85.23	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	85.43	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	84.97	84.97	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	85.23	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	83.73	83.73	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	84.97	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	82.93	82.93	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	83.73	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	65.85	65.85	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	82.93	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	54.33	54.33	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	65.85	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	34.68	34.68	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	54.33	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	32.24	32.24	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	34.68	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	29.43	29.43	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	32.24	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	28.28	28.28	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	29.43	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	19.24	19.24	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	28.28	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.79	12.79	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	19.24	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.50**	**9.50**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**12.79**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	87.84	87.84	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	98.76	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	87.84	87.84	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	87.88	6.45	HGL Too High!
P3	DI14	DI13	1.00	87.84	87.84	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	87.85	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	85.23	85.23	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	87.84	6.58	HGL Too High!
P2	DI2	DI1	1.00	84.98	84.98	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	85.00	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	84.97	84.97	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	84.98	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	88.95	88.95	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	88.98	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	88.95	88.95	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	91.07	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	82.93	82.93	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	88.95	8.13	HGL Too High!
P42	DI31	MH22	1.00	67.16	67.16	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	67.24	5.12	HGL Too High!
P43	MH22	DI32	1.00	67.09	67.09	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	67.16	5.45	HGL Too High!
P44	DI32	EX	1.00	65.85	65.85	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	67.09	5.23	HGL Too High!
P46	DI34	DI33	1.00	67.24	67.24	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	67.24	5.47	HGL Too High!
P45	DI33	DI32	1.00	67.09	67.09	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	67.24	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	34.68	34.68	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	34.68	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	83.47	83.47	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	83.71	3.63	HGL Too High!
P48	DI40	DI41	0.80	83.47	83.47	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	83.50	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	82.93	82.93	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	83.47	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	31.52	31.52	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.53	7.41	
P5	MH1	MH2	1.20	31.50	31.50	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	31.52	7.93	HGL Too High!
P7	MH2	MH3	1.20	31.46	31.46	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	31.50	7.65	HGL Too High!
P10	MH3	MH4	1.20	31.38	31.38	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	31.46	7.28	HGL Too High!
P13	MH4	MH5	1.20	31.09	31.09	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	31.38	7.09	HGL Too High!
P15	MH5	MH20	1.60	30.73	30.73	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	31.09	7.40	HGL Too High!
P6	DI16	MH2	1.00	31.50	31.50	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.51	7.33	HGL Too High!
P9	DI3	MH3	1.00	31.46	31.46	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.47	6.62	HGL Too High!
P8	DI17	MH3	1.00	31.46	31.46	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.47	6.96	HGL Too High!
P12	DI4	MH4	1.00	31.38	31.38	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	31.39	6.48	HGL Too High!
P11	DI18	MH4	1.00	31.38	31.38	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.39	6.56	HGL Too High!
P14	DI5	MH5	1.00	31.09	31.09	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.10	6.61	HGL Too High!
P18	DI6	MH6	1.00	31.12	31.12	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	31.15	7.13	HGL Too High!
P16	MH6	MH5	1.20	31.09	31.09	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	31.12	7.55	HGL Too High!
P17	DI19	MH6	1.00	31.12	31.12	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.13	7.08	HGL Too High!
P32	DI23	MH12	1.00	34.00	34.00	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	34.02	4.24	HGL Too High!
P31	DI9	MH12	1.00	34.00	34.00	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.01	7.13	HGL Too High!
P30	MH12	MH11	1.60	33.98	33.98	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	34.00	7.48	HGL Too High!
P27	MH11	MH10	1.60	33.86	33.86	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	33.98	7.21	HGL Too High!
P25	MH10	MH9	1.60	33.81	33.81	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	33.86	7.54	HGL Too High!
P22	MH9	MH8	1.60	33.72	33.72	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	33.81	7.85	HGL Too High!
P20	MH8	MH21	1.60	33.62	33.62	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	33.72	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	33.54	33.54	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	33.62	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	33.54	33.54	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	33.60	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	33.72	33.72	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	33.77	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	34.05	34.05	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	34.40	4.78	HGL Too High!
P51	STUB	DI22	1.00	34.05	34.05	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	34.10	7.16	HGL Too High!
P28	DI22	MH11	1.00	33.98	33.98	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	34.05	6.74	HGL Too High!
P29	DI8	MH11	1.00	33.98	33.98	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.98	6.92	HGL Too High!
P26	DI21	MH10	1.00	33.86	33.86	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.86	7.23	HGL Too High!
P23	DI20	MH9	1.00	33.81	33.81	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	33.82	7.38	HGL Too High!
P24	DI7	MH9	1.00	33.81	33.81	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.82	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	86.73	86.73	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	86.74	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	86.73	86.73	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	86.74	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	86.53	86.53	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	86.73	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	86.27	86.27	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	86.53	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	85.03	85.03	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	86.27	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	84.23	84.23	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	85.03	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	67.15	67.15	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	84.23	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	55.63	55.63	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	67.15	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	35.98	35.98	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	55.63	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	33.54	33.54	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	35.98	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	30.73	30.73	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	33.54	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	29.58	29.58	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	30.73	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	20.54	20.54	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	29.58	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	14.09	14.09	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	20.54	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.80**	**10.80**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**14.09**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	89.14	89.14	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	100.06	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	89.14	89.14	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	89.18	6.45	HGL Too High!
P3	DI14	DI13	1.00	89.14	89.14	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	89.15	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	86.53	86.53	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	89.14	6.58	HGL Too High!
P2	DI2	DI1	1.00	86.28	86.28	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	86.30	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	86.27	86.27	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	86.28	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	90.25	90.25	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	90.28	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	90.25	90.25	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	92.37	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	84.23	84.23	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	90.25	8.13	HGL Too High!
P42	DI31	MH22	1.00	68.46	68.46	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	68.54	5.12	HGL Too High!
P43	MH22	DI32	1.00	68.39	68.39	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	68.46	5.45	HGL Too High!
P44	DI32	EX	1.00	67.15	67.15	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	68.39	5.23	HGL Too High!
P46	DI34	DI33	1.00	68.54	68.54	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	68.54	5.47	HGL Too High!
P45	DI33	DI32	1.00	68.39	68.39	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	68.54	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	35.98	35.98	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	35.98	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	84.77	84.77	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	85.01	3.63	HGL Too High!
P48	DI40	DI41	0.80	84.77	84.77	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	84.80	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	84.23	84.23	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	84.77	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	26.46	26.46	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.47	7.41	
P5	MH1	MH2	1.20	26.44	26.44	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	26.46	7.93	HGL Too High!
P7	MH2	MH3	1.20	26.40	26.40	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	26.44	7.65	HGL Too High!
P10	MH3	MH4	1.20	26.32	26.32	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	26.40	7.28	HGL Too High!
P13	MH4	MH5	1.20	26.03	26.03	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	26.32	7.09	HGL Too High!
P15	MH5	MH20	1.60	25.67	25.67	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	26.03	7.40	HGL Too High!
P6	DI16	MH2	1.00	26.44	26.44	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.45	7.33	HGL Too High!
P9	DI3	MH3	1.00	26.40	26.40	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.41	6.62	HGL Too High!
P8	DI17	MH3	1.00	26.40	26.40	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.41	6.96	HGL Too High!
P12	DI4	MH4	1.00	26.32	26.32	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	26.33	6.48	HGL Too High!
P11	DI18	MH4	1.00	26.32	26.32	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.33	6.56	HGL Too High!
P14	DI5	MH5	1.00	26.03	26.03	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.04	6.61	HGL Too High!
P18	DI6	MH6	1.00	26.06	26.06	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	26.09	7.13	HGL Too High!
P16	MH6	MH5	1.20	26.03	26.03	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	26.06	7.55	HGL Too High!
P17	DI19	MH6	1.00	26.06	26.06	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.07	7.08	HGL Too High!
P32	DI23	MH12	1.00	28.94	28.94	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	28.96	4.24	HGL Too High!
P31	DI9	MH12	1.00	28.94	28.94	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.95	7.13	HGL Too High!
P30	MH12	MH11	1.60	28.92	28.92	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	28.94	7.48	HGL Too High!
P27	MH11	MH10	1.60	28.80	28.80	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	28.92	7.21	HGL Too High!
P25	MH10	MH9	1.60	28.75	28.75	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	28.80	7.54	HGL Too High!
P22	MH9	MH8	1.60	28.66	28.66	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	28.75	7.85	HGL Too High!
P20	MH8	MH21	1.60	28.56	28.56	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	28.66	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	28.48	28.48	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	28.56	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	28.48	28.48	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	28.54	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	28.66	28.66	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	28.71	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	28.99	28.99	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	29.34	4.78	HGL Too High!
P51	STUB	DI22	1.00	28.99	28.99	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	29.04	7.16	HGL Too High!
P28	DI22	MH11	1.00	28.92	28.92	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	28.99	6.74	HGL Too High!
P29	DI8	MH11	1.00	28.92	28.92	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.92	6.92	HGL Too High!
P26	DI21	MH10	1.00	28.80	28.80	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.80	7.23	HGL Too High!
P23	DI20	MH9	1.00	28.75	28.75	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	28.76	7.38	HGL Too High!
P24	DI7	MH9	1.00	28.75	28.75	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.76	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	81.67	81.67	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.68	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	81.67	81.67	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	81.68	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	81.47	81.47	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	81.67	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	81.21	81.21	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	81.47	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	79.97	79.97	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	81.21	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	79.17	79.17	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	79.97	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	62.09	62.09	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	79.17	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	50.57	50.57	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	62.09	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	30.92	30.92	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	50.57	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	28.48	28.48	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	30.92	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	25.67	25.67	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	28.48	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	24.52	24.52	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	25.67	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.48	15.48	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	24.52	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.03	9.03	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	15.48	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.74**	**5.74**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**9.03**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	84.08	84.08	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	95.00	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	84.08	84.08	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	84.12	6.45	HGL Too High!
P3	DI14	DI13	1.00	84.08	84.08	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	84.09	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	81.47	81.47	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	84.08	6.58	HGL Too High!
P2	DI2	DI1	1.00	81.22	81.22	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.24	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	81.21	81.21	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	81.22	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	85.19	85.19	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	85.22	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	85.19	85.19	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	87.31	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	79.17	79.17	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	85.19	8.13	HGL Too High!
P42	DI31	MH22	1.00	63.40	63.40	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	63.48	5.12	HGL Too High!
P43	MH22	DI32	1.00	63.33	63.33	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	63.40	5.45	HGL Too High!
P44	DI32	EX	1.00	62.09	62.09	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	63.33	5.23	HGL Too High!
P46	DI34	DI33	1.00	63.48	63.48	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	63.48	5.47	HGL Too High!
P45	DI33	DI32	1.00	63.33	63.33	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	63.48	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	30.92	30.92	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	30.92	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	79.71	79.71	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	79.95	3.63	HGL Too High!
P48	DI40	DI41	0.80	79.71	79.71	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	79.74	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	79.17	79.17	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	79.71	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	26.66	26.66	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	26.67	7.41	
P5	MH1	MH2	1.20	26.64	26.64	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	26.66	7.93	HGL Too High!
P7	MH2	MH3	1.20	26.60	26.60	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	26.64	7.65	HGL Too High!
P10	MH3	MH4	1.20	26.52	26.52	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	26.60	7.28	HGL Too High!
P13	MH4	MH5	1.20	26.23	26.23	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	26.52	7.09	HGL Too High!
P15	MH5	MH20	1.60	25.87	25.87	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	26.23	7.40	HGL Too High!
P6	DI16	MH2	1.00	26.64	26.64	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.65	7.33	HGL Too High!
P9	DI3	MH3	1.00	26.60	26.60	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.61	6.62	HGL Too High!
P8	DI17	MH3	1.00	26.60	26.60	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.61	6.96	HGL Too High!
P12	DI4	MH4	1.00	26.52	26.52	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	26.53	6.48	HGL Too High!
P11	DI18	MH4	1.00	26.52	26.52	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.53	6.56	HGL Too High!
P14	DI5	MH5	1.00	26.23	26.23	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.24	6.61	HGL Too High!
P18	DI6	MH6	1.00	26.26	26.26	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	26.29	7.13	HGL Too High!
P16	MH6	MH5	1.20	26.23	26.23	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	26.26	7.55	HGL Too High!
P17	DI19	MH6	1.00	26.26	26.26	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.27	7.08	HGL Too High!
P32	DI23	MH12	1.00	29.14	29.14	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	29.16	4.24	HGL Too High!
P31	DI9	MH12	1.00	29.14	29.14	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.15	7.13	HGL Too High!
P30	MH12	MH11	1.60	29.12	29.12	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	29.14	7.48	HGL Too High!
P27	MH11	MH10	1.60	29.00	29.00	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	29.12	7.21	HGL Too High!
P25	MH10	MH9	1.60	28.95	28.95	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	29.00	7.54	HGL Too High!
P22	MH9	MH8	1.60	28.86	28.86	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	28.95	7.85	HGL Too High!
P20	MH8	MH21	1.60	28.76	28.76	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	28.86	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	28.68	28.68	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	28.76	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	28.68	28.68	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	28.74	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	28.86	28.86	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	28.91	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	29.19	29.19	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	29.54	4.78	HGL Too High!
P51	STUB	DI22	1.00	29.19	29.19	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	29.24	7.16	HGL Too High!
P28	DI22	MH11	1.00	29.12	29.12	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	29.19	6.74	HGL Too High!
P29	DI8	MH11	1.00	29.12	29.12	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.12	6.92	HGL Too High!
P26	DI21	MH10	1.00	29.00	29.00	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	29.00	7.23	HGL Too High!
P23	DI20	MH9	1.00	28.95	28.95	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	28.96	7.38	HGL Too High!
P24	DI7	MH9	1.00	28.95	28.95	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.96	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	81.87	81.87	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.88	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	81.87	81.87	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	81.88	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	81.67	81.67	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	81.87	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	81.41	81.41	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	81.67	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	80.17	80.17	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	81.41	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	79.37	79.37	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	80.17	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	62.29	62.29	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	79.37	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	50.77	50.77	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	62.29	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	31.12	31.12	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	50.77	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	28.68	28.68	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	31.12	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	25.87	25.87	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	28.68	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	24.72	24.72	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	25.87	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	15.68	15.68	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	24.72	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.23	9.23	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	15.68	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.94**	**5.94**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**9.23**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	84.28	84.28	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	95.20	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	84.28	84.28	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	84.32	6.45	HGL Too High!
P3	DI14	DI13	1.00	84.28	84.28	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	84.29	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	81.67	81.67	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	84.28	6.58	HGL Too High!
P2	DI2	DI1	1.00	81.42	81.42	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	81.44	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	81.41	81.41	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	81.42	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	85.39	85.39	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	85.42	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	85.39	85.39	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	87.51	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	79.37	79.37	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	85.39	8.13	HGL Too High!
P42	DI31	MH22	1.00	63.60	63.60	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	63.68	5.12	HGL Too High!
P43	MH22	DI32	1.00	63.53	63.53	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	63.60	5.45	HGL Too High!
P44	DI32	EX	1.00	62.29	62.29	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	63.53	5.23	HGL Too High!
P46	DI34	DI33	1.00	63.68	63.68	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	63.68	5.47	HGL Too High!
P45	DI33	DI32	1.00	63.53	63.53	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	63.68	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	31.12	31.12	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	31.12	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	79.91	79.91	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	80.15	3.63	HGL Too High!
P48	DI40	DI41	0.80	79.91	79.91	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	79.94	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	79.37	79.37	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	79.91	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	30.16	30.16	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.17	7.41	
P5	MH1	MH2	1.20	30.14	30.14	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	30.16	7.93	HGL Too High!
P7	MH2	MH3	1.20	30.10	30.10	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	30.14	7.65	HGL Too High!
P10	MH3	MH4	1.20	30.02	30.02	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	30.10	7.28	HGL Too High!
P13	MH4	MH5	1.20	29.73	29.73	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	30.02	7.09	HGL Too High!
P15	MH5	MH20	1.60	29.37	29.37	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	29.73	7.40	HGL Too High!
P6	DI16	MH2	1.00	30.14	30.14	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.15	7.33	HGL Too High!
P9	DI3	MH3	1.00	30.10	30.10	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.11	6.62	HGL Too High!
P8	DI17	MH3	1.00	30.10	30.10	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.11	6.96	HGL Too High!
P12	DI4	MH4	1.00	30.02	30.02	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	30.03	6.48	HGL Too High!
P11	DI18	MH4	1.00	30.02	30.02	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.03	6.56	HGL Too High!
P14	DI5	MH5	1.00	29.73	29.73	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.74	6.61	HGL Too High!
P18	DI6	MH6	1.00	29.76	29.76	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	29.79	7.13	HGL Too High!
P16	MH6	MH5	1.20	29.73	29.73	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	29.76	7.55	HGL Too High!
P17	DI19	MH6	1.00	29.76	29.76	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.77	7.08	HGL Too High!
P32	DI23	MH12	1.00	32.64	32.64	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	32.66	4.24	HGL Too High!
P31	DI9	MH12	1.00	32.64	32.64	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.65	7.13	HGL Too High!
P30	MH12	MH11	1.60	32.62	32.62	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	32.64	7.48	HGL Too High!
P27	MH11	MH10	1.60	32.50	32.50	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	32.62	7.21	HGL Too High!
P25	MH10	MH9	1.60	32.45	32.45	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	32.50	7.54	HGL Too High!
P22	MH9	MH8	1.60	32.36	32.36	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	32.45	7.85	HGL Too High!
P20	MH8	MH21	1.60	32.26	32.26	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	32.36	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	32.18	32.18	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	32.26	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	32.18	32.18	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	32.24	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	32.36	32.36	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	32.41	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	32.69	32.69	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	33.04	4.78	HGL Too High!
P51	STUB	DI22	1.00	32.69	32.69	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	32.74	7.16	HGL Too High!
P28	DI22	MH11	1.00	32.62	32.62	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	32.69	6.74	HGL Too High!
P29	DI8	MH11	1.00	32.62	32.62	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.62	6.92	HGL Too High!
P26	DI21	MH10	1.00	32.50	32.50	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.50	7.23	HGL Too High!
P23	DI20	MH9	1.00	32.45	32.45	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	32.46	7.38	HGL Too High!
P24	DI7	MH9	1.00	32.45	32.45	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.46	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	85.37	85.37	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	85.38	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	85.37	85.37	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	85.38	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	85.17	85.17	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	85.37	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	84.91	84.91	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	85.17	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	83.67	83.67	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	84.91	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	82.87	82.87	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	83.67	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	65.79	65.79	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	82.87	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	54.27	54.27	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	65.79	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	34.62	34.62	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	54.27	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	32.18	32.18	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	34.62	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	29.37	29.37	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	32.18	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	28.22	28.22	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	29.37	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	19.18	19.18	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	28.22	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.73	12.73	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	19.18	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.44**	**9.44**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**12.73**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	87.78	87.78	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	98.70	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	87.78	87.78	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	87.82	6.45	HGL Too High!
P3	DI14	DI13	1.00	87.78	87.78	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	87.79	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	85.17	85.17	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	87.78	6.58	HGL Too High!
P2	DI2	DI1	1.00	84.92	84.92	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	84.94	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	84.91	84.91	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	84.92	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	88.89	88.89	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	88.92	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	88.89	88.89	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	91.01	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	82.87	82.87	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	88.89	8.13	HGL Too High!
P42	DI31	MH22	1.00	67.10	67.10	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	67.18	5.12	HGL Too High!
P43	MH22	DI32	1.00	67.03	67.03	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	67.10	5.45	HGL Too High!
P44	DI32	EX	1.00	65.79	65.79	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	67.03	5.23	HGL Too High!
P46	DI34	DI33	1.00	67.18	67.18	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	67.18	5.47	HGL Too High!
P45	DI33	DI32	1.00	67.03	67.03	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	67.18	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	34.62	34.62	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	34.62	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	83.41	83.41	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	83.65	3.63	HGL Too High!
P48	DI40	DI41	0.80	83.41	83.41	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	83.44	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	82.87	82.87	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	83.41	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	30.66	30.66	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	30.67	7.41	
P5	MH1	MH2	1.20	30.64	30.64	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	30.66	7.93	HGL Too High!
P7	MH2	MH3	1.20	30.60	30.60	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	30.64	7.65	HGL Too High!
P10	MH3	MH4	1.20	30.52	30.52	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	30.60	7.28	HGL Too High!
P13	MH4	MH5	1.20	30.23	30.23	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	30.52	7.09	HGL Too High!
P15	MH5	MH20	1.60	29.87	29.87	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	30.23	7.40	HGL Too High!
P6	DI16	MH2	1.00	30.64	30.64	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.65	7.33	HGL Too High!
P9	DI3	MH3	1.00	30.60	30.60	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.61	6.62	HGL Too High!
P8	DI17	MH3	1.00	30.60	30.60	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.61	6.96	HGL Too High!
P12	DI4	MH4	1.00	30.52	30.52	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	30.53	6.48	HGL Too High!
P11	DI18	MH4	1.00	30.52	30.52	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.53	6.56	HGL Too High!
P14	DI5	MH5	1.00	30.23	30.23	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.24	6.61	HGL Too High!
P18	DI6	MH6	1.00	30.26	30.26	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	30.29	7.13	HGL Too High!
P16	MH6	MH5	1.20	30.23	30.23	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	30.26	7.55	HGL Too High!
P17	DI19	MH6	1.00	30.26	30.26	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.27	7.08	HGL Too High!
P32	DI23	MH12	1.00	33.14	33.14	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	33.16	4.24	HGL Too High!
P31	DI9	MH12	1.00	33.14	33.14	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.15	7.13	HGL Too High!
P30	MH12	MH11	1.60	33.12	33.12	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	33.14	7.48	HGL Too High!
P27	MH11	MH10	1.60	33.00	33.00	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	33.12	7.21	HGL Too High!
P25	MH10	MH9	1.60	32.95	32.95	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	33.00	7.54	HGL Too High!
P22	MH9	MH8	1.60	32.86	32.86	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	32.95	7.85	HGL Too High!
P20	MH8	MH21	1.60	32.76	32.76	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	32.86	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	32.68	32.68	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	32.76	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	32.68	32.68	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	32.74	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	32.86	32.86	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	32.91	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	33.19	33.19	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	33.54	4.78	HGL Too High!
P51	STUB	DI22	1.00	33.19	33.19	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	33.24	7.16	HGL Too High!
P28	DI22	MH11	1.00	33.12	33.12	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	33.19	6.74	HGL Too High!
P29	DI8	MH11	1.00	33.12	33.12	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.12	6.92	HGL Too High!
P26	DI21	MH10	1.00	33.00	33.00	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.00	7.23	HGL Too High!
P23	DI20	MH9	1.00	32.95	32.95	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	32.96	7.38	HGL Too High!
P24	DI7	MH9	1.00	32.95	32.95	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.96	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	85.87	85.87	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	85.88	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	85.87	85.87	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	85.88	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	85.67	85.67	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	85.87	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	85.41	85.41	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	85.67	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	84.17	84.17	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	85.41	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	83.37	83.37	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	84.17	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	66.29	66.29	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	83.37	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	54.77	54.77	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	66.29	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	35.12	35.12	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	54.77	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	32.68	32.68	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	35.12	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	29.87	29.87	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	32.68	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	28.72	28.72	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	29.87	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	19.68	19.68	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	28.72	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.23	13.23	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	19.68	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.94**	**9.94**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**13.23**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	88.28	88.28	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	99.20	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	88.28	88.28	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	88.32	6.45	HGL Too High!
P3	DI14	DI13	1.00	88.28	88.28	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	88.29	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	85.67	85.67	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	88.28	6.58	HGL Too High!
P2	DI2	DI1	1.00	85.42	85.42	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	85.44	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	85.41	85.41	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	85.42	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	89.39	89.39	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	89.42	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	89.39	89.39	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	91.51	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	83.37	83.37	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	89.39	8.13	HGL Too High!
P42	DI31	MH22	1.00	67.60	67.60	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	67.68	5.12	HGL Too High!
P43	MH22	DI32	1.00	67.53	67.53	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	67.60	5.45	HGL Too High!
P44	DI32	EX	1.00	66.29	66.29	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	67.53	5.23	HGL Too High!
P46	DI34	DI33	1.00	67.68	67.68	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	67.68	5.47	HGL Too High!
P45	DI33	DI32	1.00	67.53	67.53	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	67.68	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	35.12	35.12	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	35.12	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	83.91	83.91	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	84.15	3.63	HGL Too High!
P48	DI40	DI41	0.80	83.91	83.91	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	83.94	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	83.37	83.37	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	83.91	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	31.06	31.06	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.07	7.41	
P5	MH1	MH2	1.20	31.04	31.04	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	31.06	7.93	HGL Too High!
P7	MH2	MH3	1.20	31.00	31.00	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	31.04	7.65	HGL Too High!
P10	MH3	MH4	1.20	30.92	30.92	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	31.00	7.28	HGL Too High!
P13	MH4	MH5	1.20	30.63	30.63	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	30.92	7.09	HGL Too High!
P15	MH5	MH20	1.60	30.27	30.27	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	30.63	7.40	HGL Too High!
P6	DI16	MH2	1.00	31.04	31.04	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.05	7.33	HGL Too High!
P9	DI3	MH3	1.00	31.00	31.00	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.01	6.62	HGL Too High!
P8	DI17	MH3	1.00	31.00	31.00	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.01	6.96	HGL Too High!
P12	DI4	MH4	1.00	30.92	30.92	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	30.93	6.48	HGL Too High!
P11	DI18	MH4	1.00	30.92	30.92	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.93	6.56	HGL Too High!
P14	DI5	MH5	1.00	30.63	30.63	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.64	6.61	HGL Too High!
P18	DI6	MH6	1.00	30.66	30.66	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	30.69	7.13	HGL Too High!
P16	MH6	MH5	1.20	30.63	30.63	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	30.66	7.55	HGL Too High!
P17	DI19	MH6	1.00	30.66	30.66	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.67	7.08	HGL Too High!
P32	DI23	MH12	1.00	33.54	33.54	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	33.56	4.24	HGL Too High!
P31	DI9	MH12	1.00	33.54	33.54	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.55	7.13	HGL Too High!
P30	MH12	MH11	1.60	33.52	33.52	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	33.54	7.48	HGL Too High!
P27	MH11	MH10	1.60	33.40	33.40	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	33.52	7.21	HGL Too High!
P25	MH10	MH9	1.60	33.35	33.35	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	33.40	7.54	HGL Too High!
P22	MH9	MH8	1.60	33.26	33.26	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	33.35	7.85	HGL Too High!
P20	MH8	MH21	1.60	33.16	33.16	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	33.26	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	33.08	33.08	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	33.16	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	33.08	33.08	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	33.14	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	33.26	33.26	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	33.31	7.34	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	33.59	33.59	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	33.94	4.78	HGL Too High!
P51	STUB	DI22	1.00	33.59	33.59	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	33.64	7.16	HGL Too High!
P28	DI22	MH11	1.00	33.52	33.52	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	33.59	6.74	HGL Too High!
P29	DI8	MH11	1.00	33.52	33.52	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.52	6.92	HGL Too High!
P26	DI21	MH10	1.00	33.40	33.40	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.40	7.23	HGL Too High!
P23	DI20	MH9	1.00	33.35	33.35	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	33.36	7.38	HGL Too High!
P24	DI7	MH9	1.00	33.35	33.35	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.36	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	86.27	86.27	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	86.28	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	86.27	86.27	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	86.28	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	86.07	86.07	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	86.27	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	85.81	85.81	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	86.07	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	84.57	84.57	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	85.81	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	83.77	83.77	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	84.57	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	66.69	66.69	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	83.77	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	55.17	55.17	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	66.69	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	35.52	35.52	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	55.17	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	33.08	33.08	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	35.52	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	30.27	30.27	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	33.08	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	29.12	29.12	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	30.27	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	20.08	20.08	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	29.12	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.63	13.63	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	20.08	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.34**	**10.34**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**13.63**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	88.68	88.68	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	99.60	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	88.68	88.68	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	88.72	6.45	HGL Too High!
P3	DI14	DI13	1.00	88.68	88.68	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	88.69	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	86.07	86.07	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	88.68	6.58	HGL Too High!
P2	DI2	DI1	1.00	85.82	85.82	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	85.84	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	85.81	85.81	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	85.82	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	89.79	89.79	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	89.82	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	89.79	89.79	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	91.91	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	83.77	83.77	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	89.79	8.13	HGL Too High!
P42	DI31	MH22	1.00	68.00	68.00	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	68.08	5.12	HGL Too High!
P43	MH22	DI32	1.00	67.93	67.93	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	68.00	5.45	HGL Too High!
P44	DI32	EX	1.00	66.69	66.69	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	67.93	5.23	HGL Too High!
P46	DI34	DI33	1.00	68.08	68.08	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	68.08	5.47	HGL Too High!
P45	DI33	DI32	1.00	67.93	67.93	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	68.08	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	35.52	35.52	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	35.52	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	84.31	84.31	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	84.55	3.63	HGL Too High!
P48	DI40	DI41	0.80	84.31	84.31	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	84.34	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	83.77	83.77	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	84.31	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	31.56	31.56	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.57	7.41	
P5	MH1	MH2	1.20	31.54	31.54	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	31.56	7.93	HGL Too High!
P7	MH2	MH3	1.20	31.50	31.50	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	31.54	7.65	HGL Too High!
P10	MH3	MH4	1.20	31.42	31.42	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	31.50	7.28	HGL Too High!
P13	MH4	MH5	1.20	31.13	31.13	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	31.42	7.09	HGL Too High!
P15	MH5	MH20	1.60	30.77	30.77	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	31.13	7.40	HGL Too High!
P6	DI16	MH2	1.00	31.54	31.54	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.55	7.33	HGL Too High!
P9	DI3	MH3	1.00	31.50	31.50	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.51	6.62	HGL Too High!
P8	DI17	MH3	1.00	31.50	31.50	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.51	6.96	HGL Too High!
P12	DI4	MH4	1.00	31.42	31.42	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	31.43	6.48	HGL Too High!
P11	DI18	MH4	1.00	31.42	31.42	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.43	6.56	HGL Too High!
P14	DI5	MH5	1.00	31.13	31.13	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.14	6.61	HGL Too High!
P18	DI6	MH6	1.00	31.16	31.16	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	31.19	7.13	HGL Too High!
P16	MH6	MH5	1.20	31.13	31.13	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	31.16	7.55	HGL Too High!
P17	DI19	MH6	1.00	31.16	31.16	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.17	7.08	HGL Too High!
P32	DI23	MH12	1.00	34.04	34.04	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	34.06	4.24	HGL Too High!
P31	DI9	MH12	1.00	34.04	34.04	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.05	7.13	HGL Too High!
P30	MH12	MH11	1.60	34.02	34.02	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	34.04	7.48	HGL Too High!
P27	MH11	MH10	1.60	33.90	33.90	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	34.02	7.21	HGL Too High!
P25	MH10	MH9	1.60	33.85	33.85	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	33.90	7.54	HGL Too High!
P22	MH9	MH8	1.60	33.76	33.76	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	33.85	7.85	HGL Too High!
P20	MH8	MH21	1.60	33.66	33.66	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	33.76	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	33.58	33.58	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	33.66	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	33.58	33.58	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	33.64	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	33.76	33.76	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	33.81	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	34.09	34.09	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	34.44	4.78	HGL Too High!
P51	STUB	DI22	1.00	34.09	34.09	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	34.14	7.16	HGL Too High!
P28	DI22	MH11	1.00	34.02	34.02	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	34.09	6.74	HGL Too High!
P29	DI8	MH11	1.00	34.02	34.02	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.02	6.92	HGL Too High!
P26	DI21	MH10	1.00	33.90	33.90	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.90	7.23	HGL Too High!
P23	DI20	MH9	1.00	33.85	33.85	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	33.86	7.38	HGL Too High!
P24	DI7	MH9	1.00	33.85	33.85	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.86	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	86.77	86.77	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	86.78	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	86.77	86.77	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	86.78	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	86.57	86.57	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	86.77	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	86.31	86.31	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	86.57	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	85.07	85.07	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	86.31	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	84.27	84.27	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	85.07	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	67.19	67.19	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	84.27	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	55.67	55.67	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	67.19	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	36.02	36.02	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	55.67	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	33.58	33.58	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	36.02	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	30.77	30.77	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	33.58	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	29.62	29.62	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	30.77	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	20.58	20.58	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	29.62	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	14.13	14.13	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	20.58	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.84**	**10.84**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**14.13**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	89.18	89.18	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	100.10	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	89.18	89.18	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	89.22	6.45	HGL Too High!
P3	DI14	DI13	1.00	89.18	89.18	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	89.19	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	86.57	86.57	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	89.18	6.58	HGL Too High!
P2	DI2	DI1	1.00	86.32	86.32	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	86.34	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	86.31	86.31	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	86.32	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	90.29	90.29	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	90.32	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	90.29	90.29	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	92.41	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	84.27	84.27	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	90.29	8.13	HGL Too High!
P42	DI31	MH22	1.00	68.50	68.50	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	68.58	5.12	HGL Too High!
P43	MH22	DI32	1.00	68.43	68.43	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	68.50	5.45	HGL Too High!
P44	DI32	EX	1.00	67.19	67.19	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	68.43	5.23	HGL Too High!
P46	DI34	DI33	1.00	68.58	68.58	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	68.58	5.47	HGL Too High!
P45	DI33	DI32	1.00	68.43	68.43	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	68.58	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	36.02	36.02	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	36.02	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	84.81	84.81	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	85.05	3.63	HGL Too High!
P48	DI40	DI41	0.80	84.81	84.81	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	84.84	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	84.27	84.27	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	84.81	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	32.26	32.26	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.27	7.41	
P5	MH1	MH2	1.20	32.24	32.24	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	32.26	7.93	HGL Too High!
P7	MH2	MH3	1.20	32.20	32.20	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	32.24	7.65	HGL Too High!
P10	MH3	MH4	1.20	32.12	32.12	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	32.20	7.28	HGL Too High!
P13	MH4	MH5	1.20	31.83	31.83	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	32.12	7.09	HGL Too High!
P15	MH5	MH20	1.60	31.47	31.47	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	31.83	7.40	HGL Too High!
P6	DI16	MH2	1.00	32.24	32.24	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.25	7.33	HGL Too High!
P9	DI3	MH3	1.00	32.20	32.20	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.21	6.62	HGL Too High!
P8	DI17	MH3	1.00	32.20	32.20	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.21	6.96	HGL Too High!
P12	DI4	MH4	1.00	32.12	32.12	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	32.13	6.48	HGL Too High!
P11	DI18	MH4	1.00	32.12	32.12	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.13	6.56	HGL Too High!
P14	DI5	MH5	1.00	31.83	31.83	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.84	6.61	HGL Too High!
P18	DI6	MH6	1.00	31.86	31.86	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	31.89	7.13	HGL Too High!
P16	MH6	MH5	1.20	31.83	31.83	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	31.86	7.55	HGL Too High!
P17	DI19	MH6	1.00	31.86	31.86	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.87	7.08	HGL Too High!
P32	DI23	MH12	1.00	34.74	34.74	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	34.76	4.24	HGL Too High!
P31	DI9	MH12	1.00	34.74	34.74	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.75	7.13	HGL Too High!
P30	MH12	MH11	1.60	34.72	34.72	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	34.74	7.48	HGL Too High!
P27	MH11	MH10	1.60	34.60	34.60	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	34.72	7.21	HGL Too High!
P25	MH10	MH9	1.60	34.55	34.55	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	34.60	7.54	HGL Too High!
P22	MH9	MH8	1.60	34.46	34.46	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	34.55	7.85	HGL Too High!
P20	MH8	MH21	1.60	34.36	34.36	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	34.46	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	34.28	34.28	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	34.36	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	34.28	34.28	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	34.34	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	34.46	34.46	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	34.51	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	34.79	34.79	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	35.14	4.78	HGL Too High!
P51	STUB	DI22	1.00	34.79	34.79	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	34.84	7.16	HGL Too High!
P28	DI22	MH11	1.00	34.72	34.72	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	34.79	6.74	HGL Too High!
P29	DI8	MH11	1.00	34.72	34.72	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.72	6.92	HGL Too High!
P26	DI21	MH10	1.00	34.60	34.60	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.60	7.23	HGL Too High!
P23	DI20	MH9	1.00	34.55	34.55	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	34.56	7.38	HGL Too High!
P24	DI7	MH9	1.00	34.55	34.55	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.56	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	87.47	87.47	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	87.48	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	87.47	87.47	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	87.48	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	87.27	87.27	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	87.47	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	87.01	87.01	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	87.27	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	85.77	85.77	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	87.01	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	84.97	84.97	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	85.77	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	67.89	67.89	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	84.97	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	56.37	56.37	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	67.89	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	36.72	36.72	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	56.37	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	34.28	34.28	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	36.72	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	31.47	31.47	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	34.28	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	30.32	30.32	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	31.47	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	21.28	21.28	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	30.32	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	14.83	14.83	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	21.28	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**11.54**	**11.54**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**14.83**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	89.88	89.88	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	100.80	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	89.88	89.88	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	89.92	6.45	HGL Too High!
P3	DI14	DI13	1.00	89.88	89.88	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	89.89	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	87.27	87.27	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	89.88	6.58	HGL Too High!
P2	DI2	DI1	1.00	87.02	87.02	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	87.04	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	87.01	87.01	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	87.02	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	90.99	90.99	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	91.02	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	90.99	90.99	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	93.11	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	84.97	84.97	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	90.99	8.13	HGL Too High!
P42	DI31	MH22	1.00	69.20	69.20	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	69.28	5.12	HGL Too High!
P43	MH22	DI32	1.00	69.13	69.13	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	69.20	5.45	HGL Too High!
P44	DI32	EX	1.00	67.89	67.89	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	69.13	5.23	HGL Too High!
P46	DI34	DI33	1.00	69.28	69.28	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	69.28	5.47	HGL Too High!
P45	DI33	DI32	1.00	69.13	69.13	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	69.28	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	36.72	36.72	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	36.72	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	85.51	85.51	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	85.75	3.63	HGL Too High!
P48	DI40	DI41	0.80	85.51	85.51	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	85.54	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	84.97	84.97	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	85.51	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	32.76	32.76	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.77	7.41	
P5	MH1	MH2	1.20	32.74	32.74	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	32.76	7.93	HGL Too High!
P7	MH2	MH3	1.20	32.70	32.70	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	32.74	7.65	HGL Too High!
P10	MH3	MH4	1.20	32.62	32.62	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	32.70	7.28	HGL Too High!
P13	MH4	MH5	1.20	32.33	32.33	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	32.62	7.09	HGL Too High!
P15	MH5	MH20	1.60	31.97	31.97	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	32.33	7.40	HGL Too High!
P6	DI16	MH2	1.00	32.74	32.74	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.75	7.33	HGL Too High!
P9	DI3	MH3	1.00	32.70	32.70	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.71	6.62	HGL Too High!
P8	DI17	MH3	1.00	32.70	32.70	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.71	6.96	HGL Too High!
P12	DI4	MH4	1.00	32.62	32.62	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	32.63	6.48	HGL Too High!
P11	DI18	MH4	1.00	32.62	32.62	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.63	6.56	HGL Too High!
P14	DI5	MH5	1.00	32.33	32.33	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.34	6.61	HGL Too High!
P18	DI6	MH6	1.00	32.36	32.36	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	32.39	7.13	HGL Too High!
P16	MH6	MH5	1.20	32.33	32.33	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	32.36	7.55	HGL Too High!
P17	DI19	MH6	1.00	32.36	32.36	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.37	7.08	HGL Too High!
P32	DI23	MH12	1.00	35.24	35.24	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	35.26	4.24	HGL Too High!
P31	DI9	MH12	1.00	35.24	35.24	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	35.25	7.13	HGL Too High!
P30	MH12	MH11	1.60	35.22	35.22	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	35.24	7.48	HGL Too High!
P27	MH11	MH10	1.60	35.10	35.10	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	35.22	7.21	HGL Too High!
P25	MH10	MH9	1.60	35.05	35.05	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	35.10	7.54	HGL Too High!
P22	MH9	MH8	1.60	34.96	34.96	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	35.05	7.85	HGL Too High!
P20	MH8	MH21	1.60	34.86	34.86	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	34.96	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	34.78	34.78	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	34.86	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	34.78	34.78	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	34.84	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	34.96	34.96	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	35.01	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	35.29	35.29	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	35.64	4.78	HGL Too High!
P51	STUB	DI22	1.00	35.29	35.29	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	35.34	7.16	HGL Too High!
P28	DI22	MH11	1.00	35.22	35.22	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	35.29	6.74	HGL Too High!
P29	DI8	MH11	1.00	35.22	35.22	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	35.22	6.92	HGL Too High!
P26	DI21	MH10	1.00	35.10	35.10	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	35.10	7.23	HGL Too High!
P23	DI20	MH9	1.00	35.05	35.05	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	35.06	7.38	HGL Too High!
P24	DI7	MH9	1.00	35.05	35.05	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	35.06	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	87.97	87.97	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	87.98	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	87.97	87.97	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	87.98	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	87.77	87.77	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	87.97	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	87.51	87.51	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	87.77	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	86.27	86.27	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	87.51	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	85.47	85.47	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	86.27	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	68.39	68.39	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	85.47	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	56.87	56.87	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	68.39	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	37.22	37.22	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	56.87	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	34.78	34.78	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	37.22	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	31.97	31.97	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	34.78	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	30.82	30.82	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	31.97	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	21.78	21.78	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	30.82	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	15.33	15.33	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	21.78	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**12.04**	**12.04**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**15.33**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	90.38	90.38	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	101.30	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	90.38	90.38	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	90.42	6.45	HGL Too High!
P3	DI14	DI13	1.00	90.38	90.38	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	90.39	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	87.77	87.77	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	90.38	6.58	HGL Too High!
P2	DI2	DI1	1.00	87.52	87.52	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	87.54	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	87.51	87.51	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	87.52	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	91.49	91.49	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	91.52	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	91.49	91.49	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	93.61	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	85.47	85.47	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	91.49	8.13	HGL Too High!
P42	DI31	MH22	1.00	69.70	69.70	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	69.78	5.12	HGL Too High!
P43	MH22	DI32	1.00	69.63	69.63	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	69.70	5.45	HGL Too High!
P44	DI32	EX	1.00	68.39	68.39	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	69.63	5.23	HGL Too High!
P46	DI34	DI33	1.00	69.78	69.78	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	69.78	5.47	HGL Too High!
P45	DI33	DI32	1.00	69.63	69.63	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	69.78	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	37.22	37.22	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	37.22	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	86.01	86.01	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	86.25	3.63	HGL Too High!
P48	DI40	DI41	0.80	86.01	86.01	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	86.04	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	85.47	85.47	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	86.01	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	34.06	34.06	15	0.8	0.6	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.07	7.41	
P5	MH1	MH2	1.20	34.04	34.04	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.6	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	34.06	7.93	HGL Too High!
P7	MH2	MH3	1.20	34.00	34.00	18	2.3	1.3	1	73.8	0.0004	0.03	0	0.00	0.01	1.4	0.5	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	34.04	7.65	HGL Too High!
P10	MH3	MH4	1.20	33.92	33.92	18	4.2	2.4	8	53.7	0.0014	0.07	0	0.00	0.02	3.0	0.9	0.7	1.3	0.0	1	0.00	0.03	1.0	0.5	0.02	0.09	34.00	7.28	HGL Too High!
P13	MH4	MH5	1.20	33.63	33.63	18	7.2	4.1	84	59.3	0.0040	0.24	0	0.00	0.06	9.9	1.6	1.3	2.4	0.0	8	0.01	0.10	1.0	0.5	0.05	0.29	33.92	7.09	HGL Too High!
P15	MH5	MH20	1.60	33.27	33.27	24	10.8	3.4	90	104	0.0019	0.20	0	0.00	0.05	29.2	4.0	1.2	4.1	0.1	84	0.17	0.31	1.0	0.5	0.16	0.36	33.63	7.40	HGL Too High!
P6	DI16	MH2	1.00	34.04	34.04	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.05	7.33	HGL Too High!
P9	DI3	MH3	1.00	34.00	34.00	15	1.0	0.8	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.01	6.62	HGL Too High!
P8	DI17	MH3	1.00	34.00	34.00	15	0.9	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.01	6.96	HGL Too High!
P12	DI4	MH4	1.00	33.92	33.92	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	33.93	6.48	HGL Too High!
P11	DI18	MH4	1.00	33.92	33.92	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.93	6.56	HGL Too High!
P14	DI5	MH5	1.00	33.63	33.63	15	1.2	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.64	6.61	HGL Too High!
P18	DI6	MH6	1.00	33.66	33.66	15	1.6	1.3	23	38	0.0005	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	33.69	7.13	HGL Too High!
P16	MH6	MH5	1.20	33.63	33.63	18	2.7	1.5	86	40	0.0005	0.02	0	0.00	0.01	2.1	0.9	0.0	1.3	0.0	23	0.01	0.03	1.0	0.5	0.01	0.03	33.66	7.55	HGL Too High!
P17	DI19	MH6	1.00	33.66	33.66	15	1.1	0.9	94	33	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.67	7.08	HGL Too High!
P32	DI23	MH12	1.00	36.54	36.54	15	1.3	1.1	64	33.3	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	36.56	4.24	HGL Too High!
P31	DI9	MH12	1.00	36.54	36.54	15	0.9	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	36.55	7.13	HGL Too High!
P30	MH12	MH11	1.60	36.52	36.52	24	2.2	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.7	1.4	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	36.54	7.48	HGL Too High!
P27	MH11	MH10	1.60	36.40	36.40	24	4.5	1.4	5	73.2	0.0016	0.12	0	0.00	0.01	1.6	1.4	0.9	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.12	36.52	7.21	HGL Too High!
P25	MH10	MH9	1.60	36.35	36.35	24	5.1	1.6	5	69.7	0.0004	0.03	0	0.00	0.01	6.5	0.3	0.0	1.4	0.0	5	0.00	0.02	1.0	0.5	0.01	0.04	36.40	7.54	HGL Too High!
P22	MH9	MH8	1.60	36.26	36.26	24	6.4	2.0	51	108	0.0007	0.07	0	0.00	0.02	8.2	0.5	0.4	1.6	0.0	5	0.00	0.03	1.0	0.5	0.02	0.09	36.35	7.85	HGL Too High!
P20	MH8	MH21	1.60	36.16	36.16	24	8.1	2.6	90	57.3	0.0011	0.06	0	0.00	0.03	13.1	2.8	0.0	2.0	0.0	51	0.03	0.08	1.0	0.5	0.04	0.10	36.26	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	36.08	36.08	24	8.0	2.6	21	11.3	0.0011	0.01	0	0.00	0.03	20.8	0.0	0.0	2.6	0.0	90	0.07	0.13	1.0	0.5	0.07	0.08	36.16	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	36.08	36.08	18	5.6	3.2	35	7.75	0.0024	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	36.14	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	36.26	36.26	15	1.9	1.5	35	49	0.0007	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.04	36.31	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	36.59	36.59	8	1.6	4.7	45	17	0.0156	0.27	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.35	36.94	4.78	HGL Too High!
P51	STUB	DI22	1.00	36.59	36.59	15	4.0	3.2	0	10	0.0032	0.03	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.05	36.64	7.16	HGL Too High!
P28	DI22	MH11	1.00	36.52	36.52	15	1.3	1.1	90	30.3	0.0003	0.01	0	0.00	0.00	12.8	7.7	0.0	3.2	0.1	0	0.00	0.06	1.0	1.0	0.06	0.07	36.59	6.74	HGL Too High!
P29	DI8	MH11	1.00	36.52	36.52	15	1.1	0.9	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	36.52	6.92	HGL Too High!
P26	DI21	MH10	1.00	36.40	36.40	15	0.6	0.5	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	36.40	7.23	HGL Too High!
P23	DI20	MH9	1.00	36.35	36.35	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.00	36.36	7.38	HGL Too High!
P24	DI7	MH9	1.00	36.35	36.35	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	36.36	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	89.27	89.27	15	1.1	0.9	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	89.28	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	89.27	89.27	15	1.3	1.1	90	34	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	89.28	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	89.07	89.07	15	2.4	2.0	90	154	0.0012	0.18	0	0.00	0.02	1.0	1.4	0.0	1.1	0.0	90	0.01	0.03	1.0	0.5	0.02	0.20	89.27	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	88.81	88.81	15	5.9	4.8	90	23	0.0084	0.19	0	0.00	0.09	4.8	10.7	0.0	3.0	0.0	0	0.00	0.14	1.0	0.5	0.07	0.26	89.07	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	87.57	87.57	15	7.2	5.9	0	78	0.0126	0.98	0	0.00	0.14	28.5	1.7	0.0	4.8	0.1	90	0.25	0.51	1.0	0.5	0.26	1.24	88.81	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	86.77	86.77	15	7.0	5.7	0	54	0.0119	0.64	0	0.00	0.13	42.8	0.0	0.0	5.9	0.2	0	0.00	0.32	1.0	0.5	0.16	0.80	87.57	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	69.69	69.69	15	15.8	12.9	0	263	0.0601	15.80	0	0.00	0.65	40.5	63.7	17.0	10.8	0.6	90	1.27	2.55	1.0	0.5	1.28	17.07	86.77	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	58.17	58.17	15	21.3	17.4	0	96	0.1092	10.48	0	0.00	1.17	204.2	56.6	0.0	12.9	0.9	0	0.00	2.08	1.0	0.5	1.04	11.52	69.69	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	38.52	38.52	15	20.9	17.0	60	175	0.1044	18.27	0	0.00	1.12	371.2	0.0	0.0	17.4	1.6	0	0.00	2.77	1.0	0.5	1.38	19.65	58.17	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	36.08	36.08	24	20.0	6.4	84	41	0.0078	0.32	0	0.00	0.16	354.9	0.0	0.0	17.0	1.6	60	2.52	4.24	1.0	0.5	2.12	2.44	38.52	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	33.27	33.27	24	30.8	9.8	13	124	0.0185	2.30	0	0.00	0.37	127.2	20.6	17.6	6.4	0.2	84	0.43	1.02	1.0	0.5	0.51	2.81	36.08	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	32.12	32.12	24	39.1	12.4	78	8	0.0299	0.24	0	0.00	0.60	302.1	0.0	0.0	9.8	0.5	13	0.28	1.41	1.3	0.5	0.91	1.15	33.27	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	23.08	23.08	24	39.1	12.4	0	252	0.0299	7.52	0	0.00	0.60	486.4	0.0	0.0	12.4	0.8	78	1.59	3.03	1.0	0.5	1.51	9.04	32.12	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	16.63	16.63	24	36.5	11.6	25	221	0.0261	5.76	0	0.00	0.53	486.4	0.0	0.0	12.4	0.8	0	0.00	1.37	1.0	0.5	0.68	6.45	23.08	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**13.34**	**13.34**	**24**	**35.1**	**11.2**	**0**	**98**	**0.0241**	**2.37**	**0**	**0.00**	**0.49**	**424.9**	**0.0**	**0.0**	**11.6**	**0.7**	**25**	**0.63**	**1.85**	**1.0**	**0.5**	**0.93**	**3.29**	**16.63**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	91.68	91.68	4	1.6	18.9	0	16	0.6391	10.23	0	0.00	1.38	0.0	0.0	0.0	0.0	0.0	0	0.00	1.38	1.0	0.5	0.69	10.92	102.60	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	91.68	91.68	8	0.4	1.2	90	33	0.0009	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	91.72	6.45	HGL Too High!
P3	DI14	DI13	1.00	91.68	91.68	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	91.69	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	89.07	89.07	15	3.6	3.0	0	15	0.0031	0.05	0	0.00	0.03	0.5	31.1	0.5	18.9	1.9	0	0.00	1.97	1.3	1.0	2.56	2.61	91.68	6.58	HGL Too High!
P2	DI2	DI1	1.00	88.82	88.82	15	0.9	0.7	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	88.84	6.84	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	200	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	88.81	88.81	15	1.4	1.2	111	3.34	0.0004	0.00	0	0.00	0.01	0.7	0.0	0.0	0.7	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	88.82	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	92.79	92.79	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	92.82	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	92.79	92.79	12	5.7	7.3	90	87	0.0219	1.91	0	0.00	0.21	0.0	0.0	0.0	0.0	0.0	0	0.00	0.21	1.0	1.0	0.21	2.11	94.91	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	86.77	86.77	10	5.9	10.8	90	87	0.0617	5.37	0	0.00	0.45	41.6	0.3	0.0	7.3	0.3	90	0.58	1.32	1.0	0.5	0.66	6.03	92.79	8.13	HGL Too High!
P42	DI31	MH22	1.00	71.00	71.00	15	2.4	1.9	7.5	55.8	0.0012	0.06	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.08	71.08	5.12	HGL Too High!
P43	MH22	DI32	1.00	70.93	70.93	15	2.4	1.9	80	45.1	0.0011	0.05	0	0.00	0.01	4.6	0.0	0.0	1.9	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.07	71.00	5.45	HGL Too High!
P44	DI32	EX	1.00	69.69	69.69	15	8.3	6.8	90	59.3	0.0142	0.84	0	0.00	0.18	4.5	9.3	0.0	2.7	0.0	94	0.08	0.30	1.3	1.0	0.39	1.23	70.93	5.23	HGL Too High!
P46	DI34	DI33	1.00	71.08	71.08	15	0.4	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	71.08	5.47	HGL Too High!
P45	DI33	DI32	1.00	70.93	70.93	15	3.4	2.7	94	48.5	0.0023	0.11	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.15	71.08	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	38.52	38.52	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	38.52	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	87.31	87.31	12	2.5	3.2	0	47	0.0042	0.20	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.24	87.55	3.63	HGL Too High!
P48	DI40	DI41	0.80	87.31	87.31	12	0.7	0.8	90	82.1	0.0003	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	87.34	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	86.77	86.77	12	3.7	4.6	95	41	0.0089	0.37	0	0.00	0.08	0.6	7.9	0.0	3.2	0.1	0	0.00	0.14	1.3	1.0	0.18	0.55	87.31	4.62	HGL Too High!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 500 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
MARKET ST RIVER WEST OUTFALL																										
SOUTH SECTION TO 24"																										
P4	DI15	MH1	3244	1216	4460	0.10	0.93	0.09	0.09	6.0	0.00	8.51	0.8	15	27.3	0.012	0.000133	0.005	4.1	5.0	2.9	0.16	6.16	4.49	4.35	Q ok
P5	MH1	MH2	1	0	1	0.00	1.00	0.00	0.19	6.0	6.16	8.43	1.6	18	82.7	0.012	0.000207	0.005	4.5	8.0	3.4	0.41	6.56	4.25	3.84	Q ok
P7	MH2	MH3	1	0	1	0.00	1.00	0.00	0.29	6.0	6.56	8.28	2.4	18	73.8	0.012	0.000456	0.005	4.6	8.1	3.9	0.32	6.88	3.81	3.44	Q ok
P10	MH3	MH4	1	0	1	0.00	1.00	0.00	0.54	6.0	6.88	8.17	4.4	18	53.7	0.012	0.001497	0.005	4.6	8.1	4.7	0.19	7.07	3.34	3.07	Q ok
P13	MH4	MH5	1	0	1	0.00	1.00	0.00	0.93	6.0	7.07	8.10	7.6	18	59.3	0.012	0.004406	0.005	4.3	7.7	5.1	0.19	7.27	2.97	2.70	Q ok
P15	MH5	MH20	1	0	1	0.00	1.00	0.00	1.41	6.0	7.27	8.02	11.3	24	104.1	0.012	0.002140	0.020	11.1	34.8	10.0	0.17	7.44	2.60	0.50	Q ok
P6	DI16	MH2	3400	1275	4675	0.11	0.93	0.10	0.10	6.0	0.00	8.51	0.8	15	29.3	0.012	0.000146	0.005	4.1	5.0	2.9	0.17	6.17	4.06	3.91	Q ok
P9	DI3	MH3	4110	3259	7369	0.17	0.76	0.13	0.13	6.0	0.00	8.51	1.1	15	18.3	0.012	0.000245	0.005	4.0	4.9	3.0	0.10	6.10	3.68	3.59	Q ok
P8	DI17	MH3	3878	2100	5978	0.14	0.85	0.12	0.12	6.0	0.00	8.51	1.0	15	31.3	0.012	0.000201	0.005	4.2	5.2	3.2	0.17	6.17	3.71	3.54	Q ok
P12	DI4	MH4	7109	2561	9670	0.22	0.93	0.21	0.21	6.0	0.00	6.73	1.4	15	20.1	0.012	0.000396	0.005	4.0	4.9	3.4	0.10	6.10	3.48	3.38	Q ok
P11	DI18	MH4	6435	2210	8645	0.20	0.94	0.19	0.19	6.0	0.00	6.70	1.3	15	28.4	0.012	0.000320	0.005	4.1	5.1	3.4	0.14	6.14	3.48	3.33	Q ok
P14	DI5	MH5	4974	2549	7523	0.17	0.86	0.15	0.15	6.0	0.00	8.51	1.3	15	22.6	0.012	0.000327	0.005	4.0	4.9	3.3	0.11	6.11	3.68	3.57	Q ok
P18	DI6	MH6	6937	1863	8800	0.20	0.98	0.20	0.20	6.0	0.00	8.51	1.7	15	38.0	0.012	0.000584	0.005	4.0	4.9	3.6	0.17	6.17	4.57	4.38	Q ok
P16	MH6	MH5	1	0	1	0.00	1.00	0.00	0.33	6.0	6.17	8.43	2.8	18	40.0	0.012	0.000603	0.011	6.8	12.1	5.6	0.12	6.29	3.77	3.32	Q ok
P17	DI19	MH6	4542	1703	6245	0.14	0.93	0.13	0.13	6.0	0.00	8.51	1.1	15	33.0	0.012	0.000260	0.005	4.0	4.9	3.3	0.17	6.17	4.19	4.02	Q ok
NORTH SECTION TO 24"																										
P32	DI23	MH12	5495	1914	7409	0.17	0.94	0.16	0.16	6.0	0.00	8.51	1.4	15	33.31	0.012	0.0004	0.005	4.1	5.0	3.3	0.17	6.17	3.98	3.81	Q ok
P31	DI9	MH12	4483	551	5034	0.12	1.00	0.12	0.12	6.0	0.00	8.51	1.0	15	18.3	0.012	0.0002	0.005	4.0	4.9	3.0	0.10	6.10	3.86	3.77	Q ok
P30	MH12	MH11	1	0	1	0.00	1.00	0.00	0.28	6.0	6.17	8.43	2.3	18	50.1	0.012	0.0004	0.005	4.5	8.0	3.9	0.22	6.38	3.67	3.42	Q ok
P27	MH11	MH10	1	0	1	0.00	1.00	0.00	0.57	6.0	6.38	8.36	4.7	18	73.2	0.012	0.0017	0.005	4.6	8.1	4.8	0.25	6.64	3.39	3.02	Q ok
P25	MH10	MH9	1	0	1	0.00	1.00	0.00	0.65	6.0	6.64	8.28	5.4	24	69.68	0.012	0.0005	0.006	6.3	19.7	5.1	0.23	6.86	2.92	2.47	Q ok
P22	MH9	MH8	1	0	1	0.00	1.00	0.00	0.83	6.0	6.86	8.17	6.7	24	108.3	0.012	0.0008	0.005	5.5	17.3	5.1	0.36	7.22	2.47	1.93	Q ok
P20	MH8	MH21	1	0	1	0.00	1.00	0.00	1.05	6.0	7.22	8.06	8.5	24	57.3	0.012	0.0012	0.021	11.4	35.8	9.3	0.10	7.32	1.65	0.43	Q ok
P21	MH21	EXMH1	1	0	1	0.00	1.00	0.00	1.05	6.0	7.32	8.02	8.5	24	11.3	0.012	0.0012	0.005	5.7	17.9	5.5	0.03	7.35	0.33	0.27	Q ok

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 500 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
P47	DI35	EXMH1	29988	0	29988	0.69	1.00	0.69	0.69	6.0	0.00	8.51	5.9	18	7.75	0.012	0.0026	0.008	5.8	10.3	5.9	0.02	6.02	-0.50	-0.56	Q ok
P-80	DI-80	MH-08	9967	0	9967	0.23	1.00	0.23	0.23	6.0	0.00	8.51	1.9	15	49	0.012	0.0008	0.009	5.5	6.8	4.7	0.17	6.17	4.53	4.07	Q ok
P52	TDI50	DI22	8815	0	8815	0.20	1.00	0.20	0.20	6.0	0.00	8.51	1.7	8	17	0.012	0.0173	0.010	3.8	1.3	3.1	0.09	6.09	3.92	3.75	Undersized!
P51	STUB	DI22	21322	0	21322	0.49	1.00	0.49	0.49	6.0	0.00	8.51	4.2	15	10.02	0.012	0.0035	0.005	4.0	4.9	4.6	0.04	6.04	3.79	3.74	Q ok
P28	DI22	MH11	5555	1955	7510	0.17	0.94	0.16	0.16	6.0	0.00	8.51	1.4	15	30.3	0.012	0.0004	0.005	4.0	4.9	3.4	0.15	6.15	3.64	3.49	Q ok
P29	DI8	MH11	5120	570	5690	0.13	1.00	0.13	0.13	6.0	0.00	8.51	1.1	15	18.3	0.012	0.0003	0.005	4.0	4.9	3.3	0.09	6.09	3.64	3.55	Q ok
P26	DI21	MH10	2755	930	3685	0.08	0.94	0.08	0.08	6.0	0.00	8.51	0.7	15	18.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.11	6.11	4.02	3.93	Q ok
P23	DI20	MH9	3213	1102	4315	0.10	0.94	0.09	0.09	6.0	0.00	8.51	0.8	15	29.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.17	6.17	4.53	4.38	Q ok
P24	DI7	MH9	3164	527	3691	0.08	1.00	0.08	0.08	6.0	0.00	8.51	0.7	15	28.02	0.012	0.0001	0.005	4.0	4.9	2.8	0.17	6.17	4.38	4.24	Q ok
SOUTH SECTION LOW TRUNK TO 24" OUTFALL																										
CRB-P72	CRB-DI72	CRB-MH-74	6086	0	6086	0.14	1.00	0.14	0.14	6.0	0.00	8.51	1.2	15	16	0.012	0.0003	0.019	7.8	9.6	4.7	0.06	6.06	2.60	2.30	Q ok
CRB-P73	CRB-DI73	CRB-MH-74	7042	0	7042	0.16	1.00	0.16	0.16	6.0	0.00	8.51	1.4	15	34	0.012	0.0004	0.005	4.0	4.9	3.4	0.17	6.17	1.92	1.75	Q ok
CRB-P74	CRB-MH-74	CRB-MH-67	1	0	1	0.00	1.00	0.00	0.30	6.0	6.17	8.43	2.5	15	154	0.012	0.0013	0.005	4.1	5.1	4.1	0.63	6.79	1.65	0.84	Q ok
EXP2	CRB-MH-67	EXMH3	1	0	1	0.00	1.00	0.00	0.76	6.0	6.79	8.21	6.2	15	23	0.013	0.0093	***0.003***	***2.7***	3.3	2.2	0.17	6.97	-1.14	-1.20	Undersized!
EXP3	EXMH3	EXMH4	1	0	1	0.00	1.00	0.00	0.94	6.0	6.97	8.14	7.6	15	78	0.013	0.0139	***0.003***	***2.7***	3.3	2.2	0.59	7.56	-1.20	-1.40	Undersized!
EXP4	EXMH4	EXMH5	1	0	1	0.00	1.00	0.00	0.94	6.0	7.56	7.91	7.4	15	54	0.013	0.0132	***0.003***	***2.7***	3.3	2.2	0.41	7.97	-1.40	-1.54	Undersized!
EXP5	EXMH5	EXMH6	1	0	1	0.00	1.00	0.00	2.14	6.0	7.97	7.76	16.6	15	263	0.013	0.0663	***0.003***	***2.7***	3.3	2.2	2.00	9.97	-1.54	-2.22	Undersized!
EXP6	EXMH6	EXMH7	1	0	1	0.00	1.00	0.00	3.19	6.0	9.97	7.02	22.4	15	96	0.013	0.1202	***0.003***	***2.7***	3.3	2.2	0.73	10.70	-2.22	-2.47	Undersized!
EXP7	EXMH7	EXMH8	1	0	1	0.00	1.00	0.00	3.19	6.0	10.70	6.86	21.9	15	175	0.013	0.1148	***0.003***	***2.7***	3.3	2.2	1.33	12.02	-2.47	-2.92	Undersized!
EXP8	EXMH8	EXMH9	1	0	1	0.00	1.00	0.00	3.19	6.0	12.02	6.57	21.0	24	41	0.013	0.0086	0.009	6.8	21.4	8.0	0.09	12.11	-2.92	-3.29	Q ok
EXP9	EXMH9	EXMH10	1	0	1	0.00	1.00	0.00	4.93	6.0	12.11	6.55	32.3	24	124	0.013	0.0204	0.009	6.8	21.4	5.6	0.37	12.48	-3.29	-4.40	Undersized!
EXP10	EXMH10	EXMH11	1	0	1	0.00	1.00	0.00	6.35	6.0	12.48	6.46	41.0	24	8	0.013	0.0328	***0.001***	***2.7***	8.5	2.2	0.06	12.54	-4.40	-4.41	Undersized!
EXP11	EXMH11	EXMH12	1	0	1	0.00	1.00	0.00	6.35	6.0	12.54	6.46	41.0	24	252	0.013	0.0328	***0.001***	***2.7***	8.5	2.2	1.90	14.44	-4.41	-4.76	Undersized!
EXP12	EXMH12	EXMH13	1	0	1	0.00	1.00	0.00	6.35	6.0	14.44	6.03	38.2	24	221	0.013	0.0286	***0.001***	***2.7***	8.5	2.2	1.67	16.11	-4.76	-5.07	Undersized!
EXP13	**EXMH13**	**OUTFALL**	**1**	**0**	**1**	**0.00**	1.00	**0.00**	**6.35**	**6.0**	**16.11**	5.80	36.8	**24**	**98**	**0.013**	**0.0265**	***0.001***	***2.7***	**8.5**	**2.2**	**0.74**	**16.85**	**-5.07**	**-5.21**	**Undersized!**
ROOF	COLLINS	MSS DI-13	8875	0	8875	0.20	1.00	0.20	0.20	6.0	0.00	8.51	1.7	4	16	0.012	0.7069	0.019	3.2	0.3	2.7	0.10	6.10	2.60	2.30	Undersized!

Delaware Department of Transportation
Storm Drainage Design Computations

Project: South Market Street Infrastructure Improvements | Prepared by: RKK | Design Date: 2/23/2023 | Sheet No.: ____ of ____
County: New Castle | Checked by: RKK | Model Date: 3/23/2023 | Cm. No.: 20077
Segment: Market Street Existing Conditions 24" Outfall | Storm Frequency: 500 -year (50-year for sumps)

Location			Impervious Area, C = 0.95 to Inlet	Pervious Area, C = 0.18 to Inlet	Total Area	Incremental Area	Runoff Coefficient	C x Δ A	Σ (C x Δ A)	Inlet Time	Time to Upper End	Rainfall Intensity	Design Discharge	Pipe Diameter	Length of Pipe	Roughness Coefficient	Friction Slope	Pipe Slope	Full Velocity	Full Capacity	Actual Velocity	Flow Time In Pipe	Time to Lower End	Invert at Upper End	Invert at Lower End	Capacity Check
No.	From	To	A_{imp}	A_{perv}	A_{total}	Δ A	C	CxΔA	Σ CA	T_c	T_c	I	Q	D	L	n	S_f	S_o	V_{full}	Q_{full}	V_{act}	T_t	T_t	Inv Up	Inv Dn	
			ft^2	ft^2	ft^2	Acres		Acres	Acres	min	min	in/hr	cfs	in	ft		ft/ft	ft/ft	fps	cfs	fps	min	min	ft	ft	
CRB-P75	TD-03	MSS DI-13	2341	0	2341	0.05	1.00	0.05	0.05	6.0	0.00	8.51	**0.46**	8	33	0.011	0.001025	0.0348	7.6	**2.7**	5.3	0.10	6.10	4.57	3.42	Q ok
P3	DI14	DI13	3876	441	4317	0.10	1.00	0.10	0.10	6.0	0.00	8.51	0.8	15	69.3	0.012	0.0001	0.005	4.0	4.9	2.8	0.41	6.41	4.03	3.68	Q ok
EXP1	DI13	MH67	3876	441	4317	0.10	1.00	0.10	0.46	6.0	6.41	8.36	3.8	15	15	0.013	0.0035	***0.003***	***2.7***	3.3	2.2	0.11	6.52	-1.10	-1.14	Undersized!
P2	DI2	DI1	3846	1139	4985	0.11	0.97	0.11	0.11	6.0	0.00	8.51	0.9	15	69.3	0.012	0.0002	0.005	4.0	4.9	3.0	0.38	6.38	4.03	3.68	Q ok
P1	DI1	EXMH	2301	1082	3383	0.08	0.88	0.07	0.18	6.0	6.38	8.36	1.5	15	3.34	0.012	0.0005	0.005	4.0	4.9	3.4	0.02	6.40	3.39	3.37	Q ok
CRB-P84	TD-04	EXMH	1667	0	1667	0.04	1.00	0.04	0.04	6.0	0.00	8.51	**0.33**	8	46	0.011	0.000520	0.0383	8.0	**2.8**	4.8	0.16	6.16	6.26	4.50	Q ok
EXP15	EXDI	EXMH	24757	6130	30887	0.71	1.00	0.71	0.71	6.0	0.00	8.51	**6.01**	12	87	0.012	0.024258	0.0049	3.5	**2.7**	2.8	0.51	6.51	2.00	1.57	Undersized!
EXP16	EXMH	EXMH5	1	0	1	0.00	1.00	0.00	0.74	6.0	6.51	8.32	**6.20**	10	87	0.012	0.068202	0.0049	3.1	**1.7**	2.5	0.58	7.09	2.00	1.57	Undersized!
P42	DI31	MH22	12796.5	0	12797	0.29	1.00	0.29	0.29	6.0	0.00	8.51	2.5	15	55.8	0.012	0.0013	0.005	4.0	5.0	4.0	0.23	6.23	2.00	1.72	Q ok
P43	MH22	DI32	1	0	1	0.00	1.00	0.00	0.29	6.0	6.23	8.43	2.5	15	45.1	0.012	0.0013	0.005	4.1	5.0	4.0	0.19	6.42	1.62	1.39	Q ok
P44	DI32	EX	14459.5	0	14460	0.33	1.00	0.33	1.05	6.0	6.42	8.36	8.8	15	59.3	0.012	0.0157	0.030	9.9	12.1	10.8	0.09	6.51	1.29	0.70	Q ok
P46	DI34	DI33	2420	0	2420	0.06	1.00	0.06	0.06	6.0	0.00	8.51	0.5	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.4	0.26	6.26	2.00	1.82	Q ok
P45	DI33	DI32	15975	0	15975	0.37	1.00	0.37	0.42	6.0	6.26	8.40	3.5	15	48.5	0.012	0.0026	0.007	4.7	5.8	4.9	0.16	6.42	1.72	1.39	Q ok
EXP17	EXMH	EXMH8	1	0	1	0.00	1.00	0.00	0.00	6.0	0.00	8.51	0.0	15	36.9	0.012	0.0000	0.005	4.0	4.9	2.0	0.32	6.32	2.00	1.82	Q ok
EX-P LOT	EXDI LOT	DI-MSS-41	13430	0	13430	0.31	1.00	0.31	0.31	6.0	0.00	8.51	**2.62**	12	47	0.012	0.004619	0.0074	4.2	**3.3**	4.7	0.16	6.16	2.50	2.15	Q ok
P48	DI40	DI41	3590	0	3590	0.08	1.00	0.08	0.08	6.0	0.00	8.51	0.7	12	82.1	0.012	0.0003	0.005	3.5	2.7	2.8	0.48	6.48	2.56	2.15	Q ok
P-MSS-48A	DI-MSS-41	EX-MH LOW	3072	0	3072	0.07	1.00	0.07	0.46	6.0	6.48	8.32	**3.84**	12	41	0.012	0.009890	0.0051	3.5	**2.8**	2.9	0.24	6.72	2.05	1.84	Undersized!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	25.94	25.94	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.95	7.41	
P5	MH1	MH2	1.20	25.92	25.92	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	25.94	7.93	HGL Too High!
P7	MH2	MH3	1.20	25.88	25.88	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	25.92	7.65	HGL Too High!
P10	MH3	MH4	1.20	25.78	25.78	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	25.88	7.28	HGL Too High!
P13	MH4	MH5	1.20	25.46	25.46	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	25.78	7.09	HGL Too High!
P15	MH5	MH20	1.60	25.07	25.07	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	25.46	7.40	HGL Too High!
P6	DI16	MH2	1.00	25.92	25.92	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.92	7.33	HGL Too High!
P9	DI3	MH3	1.00	25.88	25.88	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.88	6.62	HGL Too High!
P8	DI17	MH3	1.00	25.88	25.88	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.89	6.96	HGL Too High!
P12	DI4	MH4	1.00	25.78	25.78	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	25.79	6.48	HGL Too High!
P11	DI18	MH4	1.00	25.78	25.78	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.79	6.56	HGL Too High!
P14	DI5	MH5	1.00	25.46	25.46	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.47	6.61	HGL Too High!
P18	DI6	MH6	1.00	25.50	25.50	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	25.53	7.13	HGL Too High!
P16	MH6	MH5	1.20	25.46	25.46	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	25.50	7.55	HGL Too High!
P17	DI19	MH6	1.00	25.50	25.50	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.51	7.08	HGL Too High!
P32	DI23	MH12	1.00	28.67	28.67	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	28.68	4.24	HGL Too High!
P31	DI9	MH12	1.00	28.67	28.67	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.67	7.13	HGL Too High!
P30	MH12	MH11	1.60	28.64	28.64	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	28.67	7.48	HGL Too High!
P27	MH11	MH10	1.60	28.50	28.50	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	28.64	7.21	HGL Too High!
P25	MH10	MH9	1.60	28.46	28.46	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	28.50	7.54	HGL Too High!
P22	MH9	MH8	1.60	28.35	28.35	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	28.46	7.85	HGL Too High!
P20	MH8	MH21	1.60	28.24	28.24	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	28.35	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	28.15	28.15	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	28.24	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	28.15	28.15	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	28.22	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	28.35	28.35	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	28.40	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	28.71	28.71	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	29.10	4.78	HGL Too High!
P51	STUB	DI22	1.00	28.71	28.71	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	28.77	7.16	HGL Too High!
P28	DI22	MH11	1.00	28.64	28.64	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	28.71	6.74	HGL Too High!
P29	DI8	MH11	1.00	28.64	28.64	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.64	6.92	HGL Too High!
P26	DI21	MH10	1.00	28.50	28.50	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.51	7.23	HGL Too High!
P23	DI20	MH9	1.00	28.46	28.46	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	28.46	7.38	HGL Too High!
P24	DI7	MH9	1.00	28.46	28.46	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.46	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	86.76	86.76	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	86.77	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	86.76	86.76	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	86.78	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	86.54	86.54	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	86.76	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	86.25	86.25	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	86.54	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	84.88	84.88	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	86.25	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	83.99	83.99	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	84.88	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	65.15	65.15	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	83.99	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	52.46	52.46	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	65.15	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	30.84	30.84	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	52.46	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	28.15	28.15	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	30.84	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	25.07	25.07	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	28.15	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	23.80	23.80	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	25.07	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	13.87	13.87	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	23.80	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	6.81	6.81	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	13.87	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.20**	**3.20**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**6.81**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	89.42	89.42	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	101.50	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	89.42	89.42	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	89.47	6.45	HGL Too High!
P3	DI14	DI13	1.00	89.42	89.42	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	89.44	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	86.54	86.54	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	89.42	6.58	HGL Too High!
P2	DI2	DI1	1.00	86.27	86.27	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	86.28	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	86.25	86.25	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	86.27	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	90.66	90.66	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	90.68	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	90.66	90.66	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	92.99	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	83.99	83.99	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	90.66	8.13	HGL Too High!
P42	DI31	MH22	1.00	66.59	66.59	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	66.68	5.12	HGL Too High!
P43	MH22	DI32	1.00	66.51	66.51	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	66.59	5.45	HGL Too High!
P44	DI32	EX	1.00	65.15	65.15	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	66.51	5.23	HGL Too High!
P46	DI34	DI33	1.00	66.68	66.68	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	66.68	5.47	HGL Too High!
P45	DI33	DI32	1.00	66.51	66.51	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	66.68	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	30.84	30.84	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	30.84	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	84.60	84.60	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	84.86	3.63	HGL Too High!
P48	DI40	DI41	0.80	84.60	84.60	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	84.63	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	83.99	83.99	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	84.60	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	26.14	26.14	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.15	7.41	
P5	MH1	MH2	1.20	26.12	26.12	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	26.14	7.93	HGL Too High!
P7	MH2	MH3	1.20	26.08	26.08	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	26.12	7.65	HGL Too High!
P10	MH3	MH4	1.20	25.98	25.98	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	26.08	7.28	HGL Too High!
P13	MH4	MH5	1.20	25.66	25.66	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	25.98	7.09	HGL Too High!
P15	MH5	MH20	1.60	25.27	25.27	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	25.66	7.40	HGL Too High!
P6	DI16	MH2	1.00	26.12	26.12	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.12	7.33	HGL Too High!
P9	DI3	MH3	1.00	26.08	26.08	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.08	6.62	HGL Too High!
P8	DI17	MH3	1.00	26.08	26.08	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	26.09	6.96	HGL Too High!
P12	DI4	MH4	1.00	25.98	25.98	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	25.99	6.48	HGL Too High!
P11	DI18	MH4	1.00	25.98	25.98	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.99	6.56	HGL Too High!
P14	DI5	MH5	1.00	25.66	25.66	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.67	6.61	HGL Too High!
P18	DI6	MH6	1.00	25.70	25.70	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	25.73	7.13	HGL Too High!
P16	MH6	MH5	1.20	25.66	25.66	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	25.70	7.55	HGL Too High!
P17	DI19	MH6	1.00	25.70	25.70	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	25.71	7.08	HGL Too High!
P32	DI23	MH12	1.00	28.87	28.87	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	28.88	4.24	HGL Too High!
P31	DI9	MH12	1.00	28.87	28.87	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.87	7.13	HGL Too High!
P30	MH12	MH11	1.60	28.84	28.84	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	28.87	7.48	HGL Too High!
P27	MH11	MH10	1.60	28.70	28.70	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	28.84	7.21	HGL Too High!
P25	MH10	MH9	1.60	28.66	28.66	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	28.70	7.54	HGL Too High!
P22	MH9	MH8	1.60	28.55	28.55	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	28.66	7.85	HGL Too High!
P20	MH8	MH21	1.60	28.44	28.44	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	28.55	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	28.35	28.35	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	28.44	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	28.35	28.35	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	28.42	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	28.55	28.55	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	28.60	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	28.91	28.91	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	29.30	4.78	HGL Too High!
P51	STUB	DI22	1.00	28.91	28.91	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	28.97	7.16	HGL Too High!
P28	DI22	MH11	1.00	28.84	28.84	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	28.91	6.74	HGL Too High!
P29	DI8	MH11	1.00	28.84	28.84	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.84	6.92	HGL Too High!
P26	DI21	MH10	1.00	28.70	28.70	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.71	7.23	HGL Too High!
P23	DI20	MH9	1.00	28.66	28.66	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	28.66	7.38	HGL Too High!
P24	DI7	MH9	1.00	28.66	28.66	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	28.66	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	86.96	86.96	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	86.97	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	86.96	86.96	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	86.98	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	86.74	86.74	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	86.96	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	86.45	86.45	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	86.74	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	85.08	85.08	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	86.45	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	84.19	84.19	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	85.08	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	65.35	65.35	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	84.19	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	52.66	52.66	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	65.35	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	31.04	31.04	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	52.66	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	28.35	28.35	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	31.04	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	25.27	25.27	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	28.35	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	24.00	24.00	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	25.27	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	14.07	14.07	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	24.00	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	7.01	7.01	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	14.07	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**3.40**	**3.40**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**7.01**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	89.62	89.62	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	101.70	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	89.62	89.62	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	89.67	6.45	HGL Too High!
P3	DI14	DI13	1.00	89.62	89.62	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	89.64	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	86.74	86.74	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	89.62	6.58	HGL Too High!
P2	DI2	DI1	1.00	86.47	86.47	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	86.48	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	86.45	86.45	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	86.47	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	90.86	90.86	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	90.88	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	90.86	90.86	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	93.19	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	84.19	84.19	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	90.86	8.13	HGL Too High!
P42	DI31	MH22	1.00	66.79	66.79	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	66.88	5.12	HGL Too High!
P43	MH22	DI32	1.00	66.71	66.71	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	66.79	5.45	HGL Too High!
P44	DI32	EX	1.00	65.35	65.35	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	66.71	5.23	HGL Too High!
P46	DI34	DI33	1.00	66.88	66.88	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	66.88	5.47	HGL Too High!
P45	DI33	DI32	1.00	66.71	66.71	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	66.88	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	31.04	31.04	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	31.04	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	84.80	84.80	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	85.06	3.63	HGL Too High!
P48	DI40	DI41	0.80	84.80	84.80	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	84.83	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	84.19	84.19	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	84.80	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	29.64	29.64	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.65	7.41	
P5	MH1	MH2	1.20	29.62	29.62	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	29.64	7.93	HGL Too High!
P7	MH2	MH3	1.20	29.58	29.58	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	29.62	7.65	HGL Too High!
P10	MH3	MH4	1.20	29.48	29.48	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	29.58	7.28	HGL Too High!
P13	MH4	MH5	1.20	29.16	29.16	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	29.48	7.09	HGL Too High!
P15	MH5	MH20	1.60	28.77	28.77	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	29.16	7.40	HGL Too High!
P6	DI16	MH2	1.00	29.62	29.62	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.62	7.33	HGL Too High!
P9	DI3	MH3	1.00	29.58	29.58	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.58	6.62	HGL Too High!
P8	DI17	MH3	1.00	29.58	29.58	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.59	6.96	HGL Too High!
P12	DI4	MH4	1.00	29.48	29.48	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	29.49	6.48	HGL Too High!
P11	DI18	MH4	1.00	29.48	29.48	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.49	6.56	HGL Too High!
P14	DI5	MH5	1.00	29.16	29.16	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.17	6.61	HGL Too High!
P18	DI6	MH6	1.00	29.20	29.20	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	29.23	7.13	HGL Too High!
P16	MH6	MH5	1.20	29.16	29.16	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	29.20	7.55	HGL Too High!
P17	DI19	MH6	1.00	29.20	29.20	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.21	7.08	HGL Too High!
P32	DI23	MH12	1.00	32.37	32.37	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	32.38	4.24	HGL Too High!
P31	DI9	MH12	1.00	32.37	32.37	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.37	7.13	HGL Too High!
P30	MH12	MH11	1.60	32.34	32.34	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	32.37	7.48	HGL Too High!
P27	MH11	MH10	1.60	32.20	32.20	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	32.34	7.21	HGL Too High!
P25	MH10	MH9	1.60	32.16	32.16	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	32.20	7.54	HGL Too High!
P22	MH9	MH8	1.60	32.05	32.05	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	32.16	7.85	HGL Too High!
P20	MH8	MH21	1.60	31.94	31.94	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	32.05	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	31.85	31.85	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	31.94	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	31.85	31.85	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	31.92	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	32.05	32.05	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	32.10	7.34	HGL Too High!

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Hydraulic Grade Line Computations

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County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	32.41	32.41	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	32.80	4.78	HGL Too High!
P51	STUB	DI22	1.00	32.41	32.41	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	32.47	7.16	HGL Too High!
P28	DI22	MH11	1.00	32.34	32.34	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	32.41	6.74	HGL Too High!
P29	DI8	MH11	1.00	32.34	32.34	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.34	6.92	HGL Too High!
P26	DI21	MH10	1.00	32.20	32.20	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.21	7.23	HGL Too High!
P23	DI20	MH9	1.00	32.16	32.16	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	32.16	7.38	HGL Too High!
P24	DI7	MH9	1.00	32.16	32.16	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.16	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	90.46	90.46	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	90.47	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	90.46	90.46	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	90.48	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	90.24	90.24	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	90.46	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	89.95	89.95	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	90.24	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	88.58	88.58	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	89.95	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	87.69	87.69	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	88.58	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	68.85	68.85	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	87.69	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	56.16	56.16	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	68.85	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	34.54	34.54	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	56.16	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	31.85	31.85	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	34.54	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	28.77	28.77	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	31.85	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	27.50	27.50	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	28.77	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	17.57	17.57	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	27.50	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	10.51	10.51	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	17.57	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**6.90**	**6.90**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**10.51**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	93.12	93.12	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	105.20	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	93.12	93.12	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	93.17	6.45	HGL Too High!
P3	DI14	DI13	1.00	93.12	93.12	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	93.14	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	90.24	90.24	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	93.12	6.58	HGL Too High!
P2	DI2	DI1	1.00	89.97	89.97	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	89.98	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	89.95	89.95	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	89.97	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	94.36	94.36	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	94.38	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	94.36	94.36	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	96.69	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	87.69	87.69	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	94.36	8.13	HGL Too High!
P42	DI31	MH22	1.00	70.29	70.29	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	70.38	5.12	HGL Too High!
P43	MH22	DI32	1.00	70.21	70.21	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	70.29	5.45	HGL Too High!
P44	DI32	EX	1.00	68.85	68.85	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	70.21	5.23	HGL Too High!
P46	DI34	DI33	1.00	70.38	70.38	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	70.38	5.47	HGL Too High!
P45	DI33	DI32	1.00	70.21	70.21	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	70.38	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	34.54	34.54	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	34.54	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	88.30	88.30	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	88.56	3.63	HGL Too High!
P48	DI40	DI41	0.80	88.30	88.30	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	88.33	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	87.69	87.69	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	88.30	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	30.14	30.14	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.15	7.41	
P5	MH1	MH2	1.20	30.12	30.12	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	30.14	7.93	HGL Too High!
P7	MH2	MH3	1.20	30.08	30.08	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	30.12	7.65	HGL Too High!
P10	MH3	MH4	1.20	29.98	29.98	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	30.08	7.28	HGL Too High!
P13	MH4	MH5	1.20	29.66	29.66	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	29.98	7.09	HGL Too High!
P15	MH5	MH20	1.60	29.27	29.27	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	29.66	7.40	HGL Too High!
P6	DI16	MH2	1.00	30.12	30.12	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.12	7.33	HGL Too High!
P9	DI3	MH3	1.00	30.08	30.08	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.08	6.62	HGL Too High!
P8	DI17	MH3	1.00	30.08	30.08	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.09	6.96	HGL Too High!
P12	DI4	MH4	1.00	29.98	29.98	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	29.99	6.48	HGL Too High!
P11	DI18	MH4	1.00	29.98	29.98	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.99	6.56	HGL Too High!
P14	DI5	MH5	1.00	29.66	29.66	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.67	6.61	HGL Too High!
P18	DI6	MH6	1.00	29.70	29.70	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	29.73	7.13	HGL Too High!
P16	MH6	MH5	1.20	29.66	29.66	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	29.70	7.55	HGL Too High!
P17	DI19	MH6	1.00	29.70	29.70	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	29.71	7.08	HGL Too High!
P32	DI23	MH12	1.00	32.87	32.87	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	32.88	4.24	HGL Too High!
P31	DI9	MH12	1.00	32.87	32.87	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.87	7.13	HGL Too High!
P30	MH12	MH11	1.60	32.84	32.84	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	32.87	7.48	HGL Too High!
P27	MH11	MH10	1.60	32.70	32.70	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	32.84	7.21	HGL Too High!
P25	MH10	MH9	1.60	32.66	32.66	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	32.70	7.54	HGL Too High!
P22	MH9	MH8	1.60	32.55	32.55	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	32.66	7.85	HGL Too High!
P20	MH8	MH21	1.60	32.44	32.44	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	32.55	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	32.35	32.35	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	32.44	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	32.35	32.35	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	32.42	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	32.55	32.55	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	32.60	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	32.91	32.91	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	33.30	4.78	HGL Too High!
P51	STUB	DI22	1.00	32.91	32.91	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	32.97	7.16	HGL Too High!
P28	DI22	MH11	1.00	32.84	32.84	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	32.91	6.74	HGL Too High!
P29	DI8	MH11	1.00	32.84	32.84	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.84	6.92	HGL Too High!
P26	DI21	MH10	1.00	32.70	32.70	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.71	7.23	HGL Too High!
P23	DI20	MH9	1.00	32.66	32.66	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	32.66	7.38	HGL Too High!
P24	DI7	MH9	1.00	32.66	32.66	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	32.66	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	90.96	90.96	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	90.97	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	90.96	90.96	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	90.98	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	90.74	90.74	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	90.96	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	90.45	90.45	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	90.74	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	89.08	89.08	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	90.45	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	88.19	88.19	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	89.08	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	69.35	69.35	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	88.19	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	56.66	56.66	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	69.35	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	35.04	35.04	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	56.66	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	32.35	32.35	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	35.04	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	29.27	29.27	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	32.35	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	28.00	28.00	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	29.27	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	18.07	18.07	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	28.00	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.01	11.01	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	18.07	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.40**	**7.40**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**11.01**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	93.62	93.62	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	105.70	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	93.62	93.62	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	93.67	6.45	HGL Too High!
P3	DI14	DI13	1.00	93.62	93.62	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	93.64	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	90.74	90.74	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	93.62	6.58	HGL Too High!
P2	DI2	DI1	1.00	90.47	90.47	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	90.48	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	90.45	90.45	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	90.47	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	94.86	94.86	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	94.88	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	94.86	94.86	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	97.19	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	88.19	88.19	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	94.86	8.13	HGL Too High!
P42	DI31	MH22	1.00	70.79	70.79	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	70.88	5.12	HGL Too High!
P43	MH22	DI32	1.00	70.71	70.71	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	70.79	5.45	HGL Too High!
P44	DI32	EX	1.00	69.35	69.35	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	70.71	5.23	HGL Too High!
P46	DI34	DI33	1.00	70.88	70.88	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	70.88	5.47	HGL Too High!
P45	DI33	DI32	1.00	70.71	70.71	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	70.88	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	35.04	35.04	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	35.04	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	88.80	88.80	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	89.06	3.63	HGL Too High!
P48	DI40	DI41	0.80	88.80	88.80	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	88.83	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	88.19	88.19	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	88.80	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	30.54	30.54	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.55	7.41	
P5	MH1	MH2	1.20	30.52	30.52	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	30.54	7.93	HGL Too High!
P7	MH2	MH3	1.20	30.48	30.48	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	30.52	7.65	HGL Too High!
P10	MH3	MH4	1.20	30.38	30.38	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	30.48	7.28	HGL Too High!
P13	MH4	MH5	1.20	30.06	30.06	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	30.38	7.09	HGL Too High!
P15	MH5	MH20	1.60	29.67	29.67	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	30.06	7.40	HGL Too High!
P6	DI16	MH2	1.00	30.52	30.52	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.52	7.33	HGL Too High!
P9	DI3	MH3	1.00	30.48	30.48	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.48	6.62	HGL Too High!
P8	DI17	MH3	1.00	30.48	30.48	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.49	6.96	HGL Too High!
P12	DI4	MH4	1.00	30.38	30.38	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	30.39	6.48	HGL Too High!
P11	DI18	MH4	1.00	30.38	30.38	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.39	6.56	HGL Too High!
P14	DI5	MH5	1.00	30.06	30.06	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.07	6.61	HGL Too High!
P18	DI6	MH6	1.00	30.10	30.10	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	30.13	7.13	HGL Too High!
P16	MH6	MH5	1.20	30.06	30.06	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	30.10	7.55	HGL Too High!
P17	DI19	MH6	1.00	30.10	30.10	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.11	7.08	HGL Too High!
P32	DI23	MH12	1.00	33.27	33.27	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	33.28	4.24	HGL Too High!
P31	DI9	MH12	1.00	33.27	33.27	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.27	7.13	HGL Too High!
P30	MH12	MH11	1.60	33.24	33.24	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	33.27	7.48	HGL Too High!
P27	MH11	MH10	1.60	33.10	33.10	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	33.24	7.21	HGL Too High!
P25	MH10	MH9	1.60	33.06	33.06	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	33.10	7.54	HGL Too High!
P22	MH9	MH8	1.60	32.95	32.95	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	33.06	7.85	HGL Too High!
P20	MH8	MH21	1.60	32.84	32.84	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	32.95	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	32.75	32.75	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	32.84	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	32.75	32.75	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	32.82	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	32.95	32.95	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	33.00	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	33.31	33.31	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	33.70	4.78	HGL Too High!
P51	STUB	DI22	1.00	33.31	33.31	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	33.37	7.16	HGL Too High!
P28	DI22	MH11	1.00	33.24	33.24	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	33.31	6.74	HGL Too High!
P29	DI8	MH11	1.00	33.24	33.24	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.24	6.92	HGL Too High!
P26	DI21	MH10	1.00	33.10	33.10	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.11	7.23	HGL Too High!
P23	DI20	MH9	1.00	33.06	33.06	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	33.06	7.38	HGL Too High!
P24	DI7	MH9	1.00	33.06	33.06	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.06	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	91.36	91.36	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	91.37	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	91.36	91.36	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	91.38	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	91.14	91.14	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	91.36	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	90.85	90.85	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	91.14	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	89.48	89.48	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	90.85	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	88.59	88.59	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	89.48	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	69.75	69.75	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	88.59	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	57.06	57.06	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	69.75	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	35.44	35.44	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	57.06	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	32.75	32.75	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	35.44	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	29.67	29.67	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	32.75	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	28.40	28.40	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	29.67	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	18.47	18.47	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	28.40	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.41	11.41	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	18.47	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**7.80**	**7.80**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**11.41**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	94.02	94.02	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	106.10	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	94.02	94.02	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	94.07	6.45	HGL Too High!
P3	DI14	DI13	1.00	94.02	94.02	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	94.04	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	91.14	91.14	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	94.02	6.58	HGL Too High!
P2	DI2	DI1	1.00	90.87	90.87	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	90.88	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	90.85	90.85	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	90.87	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	95.26	95.26	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	95.28	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	95.26	95.26	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	97.59	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	88.59	88.59	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	95.26	8.13	HGL Too High!
P42	DI31	MH22	1.00	71.19	71.19	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	71.28	5.12	HGL Too High!
P43	MH22	DI32	1.00	71.11	71.11	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	71.19	5.45	HGL Too High!
P44	DI32	EX	1.00	69.75	69.75	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	71.11	5.23	HGL Too High!
P46	DI34	DI33	1.00	71.28	71.28	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	71.28	5.47	HGL Too High!
P45	DI33	DI32	1.00	71.11	71.11	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	71.28	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	35.44	35.44	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	35.44	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	89.20	89.20	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	89.46	3.63	HGL Too High!
P48	DI40	DI41	0.80	89.20	89.20	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	89.23	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	88.59	88.59	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	89.20	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	31.04	31.04	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.05	7.41	
P5	MH1	MH2	1.20	31.02	31.02	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	31.04	7.93	HGL Too High!
P7	MH2	MH3	1.20	30.98	30.98	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	31.02	7.65	HGL Too High!
P10	MH3	MH4	1.20	30.88	30.88	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	30.98	7.28	HGL Too High!
P13	MH4	MH5	1.20	30.56	30.56	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	30.88	7.09	HGL Too High!
P15	MH5	MH20	1.60	30.17	30.17	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	30.56	7.40	HGL Too High!
P6	DI16	MH2	1.00	31.02	31.02	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.02	7.33	HGL Too High!
P9	DI3	MH3	1.00	30.98	30.98	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.98	6.62	HGL Too High!
P8	DI17	MH3	1.00	30.98	30.98	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.99	6.96	HGL Too High!
P12	DI4	MH4	1.00	30.88	30.88	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	30.89	6.48	HGL Too High!
P11	DI18	MH4	1.00	30.88	30.88	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.89	6.56	HGL Too High!
P14	DI5	MH5	1.00	30.56	30.56	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.57	6.61	HGL Too High!
P18	DI6	MH6	1.00	30.60	30.60	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	30.63	7.13	HGL Too High!
P16	MH6	MH5	1.20	30.56	30.56	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	30.60	7.55	HGL Too High!
P17	DI19	MH6	1.00	30.60	30.60	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	30.61	7.08	HGL Too High!
P32	DI23	MH12	1.00	33.77	33.77	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	33.78	4.24	HGL Too High!
P31	DI9	MH12	1.00	33.77	33.77	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.77	7.13	HGL Too High!
P30	MH12	MH11	1.60	33.74	33.74	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	33.77	7.48	HGL Too High!
P27	MH11	MH10	1.60	33.60	33.60	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	33.74	7.21	HGL Too High!
P25	MH10	MH9	1.60	33.56	33.56	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	33.60	7.54	HGL Too High!
P22	MH9	MH8	1.60	33.45	33.45	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	33.56	7.85	HGL Too High!
P20	MH8	MH21	1.60	33.34	33.34	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	33.45	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	33.25	33.25	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	33.34	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	33.25	33.25	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	33.32	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	33.45	33.45	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	33.50	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	33.81	33.81	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	34.20	4.78	HGL Too High!
P51	STUB	DI22	1.00	33.81	33.81	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	33.87	7.16	HGL Too High!
P28	DI22	MH11	1.00	33.74	33.74	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	33.81	6.74	HGL Too High!
P29	DI8	MH11	1.00	33.74	33.74	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.74	6.92	HGL Too High!
P26	DI21	MH10	1.00	33.60	33.60	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.61	7.23	HGL Too High!
P23	DI20	MH9	1.00	33.56	33.56	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	33.56	7.38	HGL Too High!
P24	DI7	MH9	1.00	33.56	33.56	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	33.56	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	91.86	91.86	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	91.87	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	91.86	91.86	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	91.88	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	91.64	91.64	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	91.86	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	91.35	91.35	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	91.64	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	89.98	89.98	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	91.35	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	89.09	89.09	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	89.98	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	70.25	70.25	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	89.09	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	57.56	57.56	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	70.25	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	35.94	35.94	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	57.56	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	33.25	33.25	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	35.94	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	30.17	30.17	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	33.25	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	28.90	28.90	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	30.17	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	18.97	18.97	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	28.90	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	11.91	11.91	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	18.97	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**8.30**	**8.30**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**11.91**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	94.52	94.52	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	106.60	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	94.52	94.52	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	94.57	6.45	HGL Too High!
P3	DI14	DI13	1.00	94.52	94.52	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	94.54	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	91.64	91.64	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	94.52	6.58	HGL Too High!
P2	DI2	DI1	1.00	91.37	91.37	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	91.38	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	91.35	91.35	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	91.37	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	95.76	95.76	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	95.78	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	95.76	95.76	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	98.09	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	89.09	89.09	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	95.76	8.13	HGL Too High!
P42	DI31	MH22	1.00	71.69	71.69	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	71.78	5.12	HGL Too High!
P43	MH22	DI32	1.00	71.61	71.61	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	71.69	5.45	HGL Too High!
P44	DI32	EX	1.00	70.25	70.25	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	71.61	5.23	HGL Too High!
P46	DI34	DI33	1.00	71.78	71.78	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	71.78	5.47	HGL Too High!
P45	DI33	DI32	1.00	71.61	71.61	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	71.78	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	35.94	35.94	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	35.94	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	89.70	89.70	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	89.96	3.63	HGL Too High!
P48	DI40	DI41	0.80	89.70	89.70	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	89.73	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	89.09	89.09	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	89.70	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	31.74	31.74	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.75	7.41	
P5	MH1	MH2	1.20	31.72	31.72	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	31.74	7.93	HGL Too High!
P7	MH2	MH3	1.20	31.68	31.68	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	31.72	7.65	HGL Too High!
P10	MH3	MH4	1.20	31.58	31.58	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	31.68	7.28	HGL Too High!
P13	MH4	MH5	1.20	31.26	31.26	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	31.58	7.09	HGL Too High!
P15	MH5	MH20	1.60	30.87	30.87	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	31.26	7.40	HGL Too High!
P6	DI16	MH2	1.00	31.72	31.72	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.72	7.33	HGL Too High!
P9	DI3	MH3	1.00	31.68	31.68	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.68	6.62	HGL Too High!
P8	DI17	MH3	1.00	31.68	31.68	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.69	6.96	HGL Too High!
P12	DI4	MH4	1.00	31.58	31.58	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	31.59	6.48	HGL Too High!
P11	DI18	MH4	1.00	31.58	31.58	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.59	6.56	HGL Too High!
P14	DI5	MH5	1.00	31.26	31.26	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.27	6.61	HGL Too High!
P18	DI6	MH6	1.00	31.30	31.30	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	31.33	7.13	HGL Too High!
P16	MH6	MH5	1.20	31.26	31.26	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	31.30	7.55	HGL Too High!
P17	DI19	MH6	1.00	31.30	31.30	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.31	7.08	HGL Too High!
P32	DI23	MH12	1.00	34.47	34.47	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	34.48	4.24	HGL Too High!
P31	DI9	MH12	1.00	34.47	34.47	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.47	7.13	HGL Too High!
P30	MH12	MH11	1.60	34.44	34.44	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	34.47	7.48	HGL Too High!
P27	MH11	MH10	1.60	34.30	34.30	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	34.44	7.21	HGL Too High!
P25	MH10	MH9	1.60	34.26	34.26	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	34.30	7.54	HGL Too High!
P22	MH9	MH8	1.60	34.15	34.15	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	34.26	7.85	HGL Too High!
P20	MH8	MH21	1.60	34.04	34.04	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	34.15	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	33.95	33.95	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	34.04	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	33.95	33.95	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	34.02	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	34.15	34.15	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	34.20	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	34.51	34.51	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	34.90	4.78	HGL Too High!
P51	STUB	DI22	1.00	34.51	34.51	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	34.57	7.16	HGL Too High!
P28	DI22	MH11	1.00	34.44	34.44	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	34.51	6.74	HGL Too High!
P29	DI8	MH11	1.00	34.44	34.44	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.44	6.92	HGL Too High!
P26	DI21	MH10	1.00	34.30	34.30	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.31	7.23	HGL Too High!
P23	DI20	MH9	1.00	34.26	34.26	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	34.26	7.38	HGL Too High!
P24	DI7	MH9	1.00	34.26	34.26	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.26	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	92.56	92.56	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	92.57	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	92.56	92.56	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	92.58	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	92.34	92.34	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	92.56	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	92.05	92.05	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	92.34	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	90.68	90.68	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	92.05	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	89.79	89.79	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	90.68	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	70.95	70.95	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	89.79	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	58.26	58.26	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	70.95	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	36.64	36.64	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	58.26	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	33.95	33.95	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	36.64	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	30.87	30.87	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	33.95	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	29.60	29.60	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	30.87	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	19.67	19.67	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	29.60	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	12.61	12.61	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	19.67	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.00**	**9.00**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**12.61**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	95.22	95.22	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	107.30	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	95.22	95.22	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	95.27	6.45	HGL Too High!
P3	DI14	DI13	1.00	95.22	95.22	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	95.24	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	92.34	92.34	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	95.22	6.58	HGL Too High!
P2	DI2	DI1	1.00	92.07	92.07	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	92.08	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	92.05	92.05	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	92.07	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	96.46	96.46	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	96.48	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	96.46	96.46	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	98.79	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	89.79	89.79	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	96.46	8.13	HGL Too High!
P42	DI31	MH22	1.00	72.39	72.39	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	72.48	5.12	HGL Too High!
P43	MH22	DI32	1.00	72.31	72.31	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	72.39	5.45	HGL Too High!
P44	DI32	EX	1.00	70.95	70.95	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	72.31	5.23	HGL Too High!
P46	DI34	DI33	1.00	72.48	72.48	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	72.48	5.47	HGL Too High!
P45	DI33	DI32	1.00	72.31	72.31	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	72.48	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	36.64	36.64	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	36.64	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	90.40	90.40	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	90.66	3.63	HGL Too High!
P48	DI40	DI41	0.80	90.40	90.40	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	90.43	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	89.79	89.79	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	90.40	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	32.24	32.24	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.25	7.41	
P5	MH1	MH2	1.20	32.22	32.22	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	32.24	7.93	HGL Too High!
P7	MH2	MH3	1.20	32.18	32.18	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	32.22	7.65	HGL Too High!
P10	MH3	MH4	1.20	32.08	32.08	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	32.18	7.28	HGL Too High!
P13	MH4	MH5	1.20	31.76	31.76	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	32.08	7.09	HGL Too High!
P15	MH5	MH20	1.60	31.37	31.37	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	31.76	7.40	HGL Too High!
P6	DI16	MH2	1.00	32.22	32.22	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.22	7.33	HGL Too High!
P9	DI3	MH3	1.00	32.18	32.18	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.18	6.62	HGL Too High!
P8	DI17	MH3	1.00	32.18	32.18	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.19	6.96	HGL Too High!
P12	DI4	MH4	1.00	32.08	32.08	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	32.09	6.48	HGL Too High!
P11	DI18	MH4	1.00	32.08	32.08	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.09	6.56	HGL Too High!
P14	DI5	MH5	1.00	31.76	31.76	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.77	6.61	HGL Too High!
P18	DI6	MH6	1.00	31.80	31.80	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	31.83	7.13	HGL Too High!
P16	MH6	MH5	1.20	31.76	31.76	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	31.80	7.55	HGL Too High!
P17	DI19	MH6	1.00	31.80	31.80	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.81	7.08	HGL Too High!
P32	DI23	MH12	1.00	34.97	34.97	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	34.98	4.24	HGL Too High!
P31	DI9	MH12	1.00	34.97	34.97	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.97	7.13	HGL Too High!
P30	MH12	MH11	1.60	34.94	34.94	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	34.97	7.48	HGL Too High!
P27	MH11	MH10	1.60	34.80	34.80	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	34.94	7.21	HGL Too High!
P25	MH10	MH9	1.60	34.76	34.76	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	34.80	7.54	HGL Too High!
P22	MH9	MH8	1.60	34.65	34.65	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	34.76	7.85	HGL Too High!
P20	MH8	MH21	1.60	34.54	34.54	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	34.65	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	34.45	34.45	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	34.54	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	34.45	34.45	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	34.52	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	34.65	34.65	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	34.70	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	35.01	35.01	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	35.40	4.78	HGL Too High!
P51	STUB	DI22	1.00	35.01	35.01	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	35.07	7.16	HGL Too High!
P28	DI22	MH11	1.00	34.94	34.94	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	35.01	6.74	HGL Too High!
P29	DI8	MH11	1.00	34.94	34.94	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.94	6.92	HGL Too High!
P26	DI21	MH10	1.00	34.80	34.80	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.81	7.23	HGL Too High!
P23	DI20	MH9	1.00	34.76	34.76	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	34.76	7.38	HGL Too High!
P24	DI7	MH9	1.00	34.76	34.76	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.76	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	93.06	93.06	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	93.07	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	93.06	93.06	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	93.08	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	92.84	92.84	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	93.06	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	92.55	92.55	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	92.84	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	91.18	91.18	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	92.55	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	90.29	90.29	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	91.18	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	71.45	71.45	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	90.29	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	58.76	58.76	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	71.45	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	37.14	37.14	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	58.76	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	34.45	34.45	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	37.14	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	31.37	31.37	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	34.45	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	30.10	30.10	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	31.37	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	20.17	20.17	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	30.10	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.11	13.11	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	20.17	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.50**	**9.50**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**13.11**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	95.72	95.72	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	107.80	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	95.72	95.72	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	95.77	6.45	HGL Too High!
P3	DI14	DI13	1.00	95.72	95.72	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	95.74	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	92.84	92.84	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	95.72	6.58	HGL Too High!
P2	DI2	DI1	1.00	92.57	92.57	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	92.58	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	92.55	92.55	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	92.57	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	96.96	96.96	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	96.98	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	96.96	96.96	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	99.29	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	90.29	90.29	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	96.96	8.13	HGL Too High!
P42	DI31	MH22	1.00	72.89	72.89	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	72.98	5.12	HGL Too High!
P43	MH22	DI32	1.00	72.81	72.81	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	72.89	5.45	HGL Too High!
P44	DI32	EX	1.00	71.45	71.45	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	72.81	5.23	HGL Too High!
P46	DI34	DI33	1.00	72.98	72.98	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	72.98	5.47	HGL Too High!
P45	DI33	DI32	1.00	72.81	72.81	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	72.98	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	37.14	37.14	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	37.14	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	90.90	90.90	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	91.16	3.63	HGL Too High!
P48	DI40	DI41	0.80	90.90	90.90	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	90.93	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	90.29	90.29	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	90.90	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	33.54	33.54	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.55	7.41	
P5	MH1	MH2	1.20	33.52	33.52	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	33.54	7.93	HGL Too High!
P7	MH2	MH3	1.20	33.48	33.48	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	33.52	7.65	HGL Too High!
P10	MH3	MH4	1.20	33.38	33.38	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	33.48	7.28	HGL Too High!
P13	MH4	MH5	1.20	33.06	33.06	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	33.38	7.09	HGL Too High!
P15	MH5	MH20	1.60	32.67	32.67	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	33.06	7.40	HGL Too High!
P6	DI16	MH2	1.00	33.52	33.52	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.52	7.33	HGL Too High!
P9	DI3	MH3	1.00	33.48	33.48	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.48	6.62	HGL Too High!
P8	DI17	MH3	1.00	33.48	33.48	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.49	6.96	HGL Too High!
P12	DI4	MH4	1.00	33.38	33.38	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	33.39	6.48	HGL Too High!
P11	DI18	MH4	1.00	33.38	33.38	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.39	6.56	HGL Too High!
P14	DI5	MH5	1.00	33.06	33.06	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.07	6.61	HGL Too High!
P18	DI6	MH6	1.00	33.10	33.10	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	33.13	7.13	HGL Too High!
P16	MH6	MH5	1.20	33.06	33.06	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	33.10	7.55	HGL Too High!
P17	DI19	MH6	1.00	33.10	33.10	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.11	7.08	HGL Too High!
P32	DI23	MH12	1.00	36.27	36.27	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	36.28	4.24	HGL Too High!
P31	DI9	MH12	1.00	36.27	36.27	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	36.27	7.13	HGL Too High!
P30	MH12	MH11	1.60	36.24	36.24	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	36.27	7.48	HGL Too High!
P27	MH11	MH10	1.60	36.10	36.10	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	36.24	7.21	HGL Too High!
P25	MH10	MH9	1.60	36.06	36.06	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	36.10	7.54	HGL Too High!
P22	MH9	MH8	1.60	35.95	35.95	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	36.06	7.85	HGL Too High!
P20	MH8	MH21	1.60	35.84	35.84	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	35.95	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	35.75	35.75	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	35.84	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	35.75	35.75	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	35.82	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	35.95	35.95	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	36.00	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	36.31	36.31	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	36.70	4.78	HGL Too High!
P51	STUB	DI22	1.00	36.31	36.31	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	36.37	7.16	HGL Too High!
P28	DI22	MH11	1.00	36.24	36.24	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	36.31	6.74	HGL Too High!
P29	DI8	MH11	1.00	36.24	36.24	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	36.24	6.92	HGL Too High!
P26	DI21	MH10	1.00	36.10	36.10	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	36.11	7.23	HGL Too High!
P23	DI20	MH9	1.00	36.06	36.06	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	36.06	7.38	HGL Too High!
P24	DI7	MH9	1.00	36.06	36.06	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	36.06	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	94.36	94.36	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	94.37	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	94.36	94.36	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	94.38	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	94.14	94.14	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	94.36	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	93.85	93.85	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	94.14	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	92.48	92.48	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	93.85	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	91.59	91.59	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	92.48	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	72.75	72.75	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	91.59	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	60.06	60.06	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	72.75	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	38.44	38.44	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	60.06	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	35.75	35.75	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	38.44	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	32.67	32.67	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	35.75	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	31.40	31.40	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	32.67	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	21.47	21.47	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	31.40	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	14.41	14.41	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	21.47	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.80**	**10.80**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**14.41**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	97.02	97.02	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	109.10	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	97.02	97.02	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	97.07	6.45	HGL Too High!
P3	DI14	DI13	1.00	97.02	97.02	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	97.04	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	94.14	94.14	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	97.02	6.58	HGL Too High!
P2	DI2	DI1	1.00	93.87	93.87	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	93.88	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	93.85	93.85	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	93.87	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	98.26	98.26	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	98.28	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	98.26	98.26	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	100.59	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	91.59	91.59	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	98.26	8.13	HGL Too High!
P42	DI31	MH22	1.00	74.19	74.19	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	74.28	5.12	HGL Too High!
P43	MH22	DI32	1.00	74.11	74.11	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	74.19	5.45	HGL Too High!
P44	DI32	EX	1.00	72.75	72.75	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	74.11	5.23	HGL Too High!
P46	DI34	DI33	1.00	74.28	74.28	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	74.28	5.47	HGL Too High!
P45	DI33	DI32	1.00	74.11	74.11	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	74.28	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	38.44	38.44	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	38.44	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	92.20	92.20	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	92.46	3.63	HGL Too High!
P48	DI40	DI41	0.80	92.20	92.20	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	92.23	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	91.59	91.59	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	92.20	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	28.48	28.48	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.49	7.41	
P5	MH1	MH2	1.20	28.46	28.46	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	28.48	7.93	HGL Too High!
P7	MH2	MH3	1.20	28.42	28.42	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	28.46	7.65	HGL Too High!
P10	MH3	MH4	1.20	28.32	28.32	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	28.42	7.28	HGL Too High!
P13	MH4	MH5	1.20	28.00	28.00	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	28.32	7.09	HGL Too High!
P15	MH5	MH20	1.60	27.61	27.61	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	28.00	7.40	HGL Too High!
P6	DI16	MH2	1.00	28.46	28.46	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.46	7.33	HGL Too High!
P9	DI3	MH3	1.00	28.42	28.42	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.42	6.62	HGL Too High!
P8	DI17	MH3	1.00	28.42	28.42	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.43	6.96	HGL Too High!
P12	DI4	MH4	1.00	28.32	28.32	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	28.33	6.48	HGL Too High!
P11	DI18	MH4	1.00	28.32	28.32	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.33	6.56	HGL Too High!
P14	DI5	MH5	1.00	28.00	28.00	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.01	6.61	HGL Too High!
P18	DI6	MH6	1.00	28.04	28.04	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	28.07	7.13	HGL Too High!
P16	MH6	MH5	1.20	28.00	28.00	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	28.04	7.55	HGL Too High!
P17	DI19	MH6	1.00	28.04	28.04	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.05	7.08	HGL Too High!
P32	DI23	MH12	1.00	31.21	31.21	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	31.22	4.24	HGL Too High!
P31	DI9	MH12	1.00	31.21	31.21	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.21	7.13	HGL Too High!
P30	MH12	MH11	1.60	31.18	31.18	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	31.21	7.48	HGL Too High!
P27	MH11	MH10	1.60	31.04	31.04	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	31.18	7.21	HGL Too High!
P25	MH10	MH9	1.60	31.00	31.00	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	31.04	7.54	HGL Too High!
P22	MH9	MH8	1.60	30.89	30.89	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	31.00	7.85	HGL Too High!
P20	MH8	MH21	1.60	30.78	30.78	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	30.89	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	30.69	30.69	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	30.78	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	30.69	30.69	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	30.76	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	30.89	30.89	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	30.94	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	31.25	31.25	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	31.64	4.78	HGL Too High!
P51	STUB	DI22	1.00	31.25	31.25	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	31.31	7.16	HGL Too High!
P28	DI22	MH11	1.00	31.18	31.18	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	31.25	6.74	HGL Too High!
P29	DI8	MH11	1.00	31.18	31.18	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.18	6.92	HGL Too High!
P26	DI21	MH10	1.00	31.04	31.04	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.05	7.23	HGL Too High!
P23	DI20	MH9	1.00	31.00	31.00	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	31.00	7.38	HGL Too High!
P24	DI7	MH9	1.00	31.00	31.00	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.00	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	89.30	89.30	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	89.31	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	89.30	89.30	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	89.32	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	89.08	89.08	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	89.30	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	88.79	88.79	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	89.08	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	87.42	87.42	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	88.79	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	86.53	86.53	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	87.42	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	67.69	67.69	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	86.53	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	55.00	55.00	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	67.69	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	33.38	33.38	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	55.00	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	30.69	30.69	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	33.38	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	27.61	27.61	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	30.69	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	26.34	26.34	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	27.61	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	16.41	16.41	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	26.34	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.35	9.35	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	16.41	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.74**	**5.74**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**9.35**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	91.96	91.96	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	104.04	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	91.96	91.96	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	92.01	6.45	HGL Too High!
P3	DI14	DI13	1.00	91.96	91.96	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	91.98	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	89.08	89.08	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	91.96	6.58	HGL Too High!
P2	DI2	DI1	1.00	88.81	88.81	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	88.82	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	88.79	88.79	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	88.81	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	93.20	93.20	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	93.22	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	93.20	93.20	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	95.53	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	86.53	86.53	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	93.20	8.13	HGL Too High!
P42	DI31	MH22	1.00	69.13	69.13	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	69.22	5.12	HGL Too High!
P43	MH22	DI32	1.00	69.05	69.05	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	69.13	5.45	HGL Too High!
P44	DI32	EX	1.00	67.69	67.69	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	69.05	5.23	HGL Too High!
P46	DI34	DI33	1.00	69.22	69.22	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	69.22	5.47	HGL Too High!
P45	DI33	DI32	1.00	69.05	69.05	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	69.22	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	33.38	33.38	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	33.38	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	87.14	87.14	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	87.40	3.63	HGL Too High!
P48	DI40	DI41	0.80	87.14	87.14	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	87.17	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	86.53	86.53	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	87.14	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	28.68	28.68	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.69	7.41	
P5	MH1	MH2	1.20	28.66	28.66	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	28.68	7.93	HGL Too High!
P7	MH2	MH3	1.20	28.62	28.62	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	28.66	7.65	HGL Too High!
P10	MH3	MH4	1.20	28.52	28.52	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	28.62	7.28	HGL Too High!
P13	MH4	MH5	1.20	28.20	28.20	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	28.52	7.09	HGL Too High!
P15	MH5	MH20	1.60	27.81	27.81	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	28.20	7.40	HGL Too High!
P6	DI16	MH2	1.00	28.66	28.66	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.66	7.33	HGL Too High!
P9	DI3	MH3	1.00	28.62	28.62	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.62	6.62	HGL Too High!
P8	DI17	MH3	1.00	28.62	28.62	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.63	6.96	HGL Too High!
P12	DI4	MH4	1.00	28.52	28.52	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	28.53	6.48	HGL Too High!
P11	DI18	MH4	1.00	28.52	28.52	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.53	6.56	HGL Too High!
P14	DI5	MH5	1.00	28.20	28.20	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.21	6.61	HGL Too High!
P18	DI6	MH6	1.00	28.24	28.24	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	28.27	7.13	HGL Too High!
P16	MH6	MH5	1.20	28.20	28.20	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	28.24	7.55	HGL Too High!
P17	DI19	MH6	1.00	28.24	28.24	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	28.25	7.08	HGL Too High!
P32	DI23	MH12	1.00	31.41	31.41	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	31.42	4.24	HGL Too High!
P31	DI9	MH12	1.00	31.41	31.41	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.41	7.13	HGL Too High!
P30	MH12	MH11	1.60	31.38	31.38	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	31.41	7.48	HGL Too High!
P27	MH11	MH10	1.60	31.24	31.24	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	31.38	7.21	HGL Too High!
P25	MH10	MH9	1.60	31.20	31.20	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	31.24	7.54	HGL Too High!
P22	MH9	MH8	1.60	31.09	31.09	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	31.20	7.85	HGL Too High!
P20	MH8	MH21	1.60	30.98	30.98	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	31.09	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	30.89	30.89	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	30.98	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	30.89	30.89	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	30.96	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	31.09	31.09	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	31.14	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	31.45	31.45	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	31.84	4.78	HGL Too High!
P51	STUB	DI22	1.00	31.45	31.45	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	31.51	7.16	HGL Too High!
P28	DI22	MH11	1.00	31.38	31.38	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	31.45	6.74	HGL Too High!
P29	DI8	MH11	1.00	31.38	31.38	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.38	6.92	HGL Too High!
P26	DI21	MH10	1.00	31.24	31.24	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.25	7.23	HGL Too High!
P23	DI20	MH9	1.00	31.20	31.20	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	31.20	7.38	HGL Too High!
P24	DI7	MH9	1.00	31.20	31.20	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	31.20	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	89.50	89.50	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	89.51	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	89.50	89.50	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	89.52	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	89.28	89.28	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	89.50	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	88.99	88.99	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	89.28	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	87.62	87.62	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	88.99	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	86.73	86.73	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	87.62	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	67.89	67.89	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	86.73	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	55.20	55.20	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	67.89	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	33.58	33.58	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	55.20	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	30.89	30.89	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	33.58	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	27.81	27.81	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	30.89	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	26.54	26.54	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	27.81	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	16.61	16.61	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	26.54	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	9.55	9.55	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	16.61	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**5.94**	**5.94**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**9.55**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	92.16	92.16	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	104.24	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	92.16	92.16	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	92.21	6.45	HGL Too High!
P3	DI14	DI13	1.00	92.16	92.16	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	92.18	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	89.28	89.28	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	92.16	6.58	HGL Too High!
P2	DI2	DI1	1.00	89.01	89.01	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	89.02	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	88.99	88.99	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	89.01	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	93.40	93.40	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	93.42	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	93.40	93.40	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	95.73	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	86.73	86.73	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	93.40	8.13	HGL Too High!
P42	DI31	MH22	1.00	69.33	69.33	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	69.42	5.12	HGL Too High!
P43	MH22	DI32	1.00	69.25	69.25	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	69.33	5.45	HGL Too High!
P44	DI32	EX	1.00	67.89	67.89	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	69.25	5.23	HGL Too High!
P46	DI34	DI33	1.00	69.42	69.42	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	69.42	5.47	HGL Too High!
P45	DI33	DI32	1.00	69.25	69.25	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	69.42	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	33.58	33.58	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	33.58	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	87.34	87.34	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	87.60	3.63	HGL Too High!
P48	DI40	DI41	0.80	87.34	87.34	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	87.37	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	86.73	86.73	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	87.34	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	32.18	32.18	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.19	7.41	
P5	MH1	MH2	1.20	32.16	32.16	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	32.18	7.93	HGL Too High!
P7	MH2	MH3	1.20	32.12	32.12	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	32.16	7.65	HGL Too High!
P10	MH3	MH4	1.20	32.02	32.02	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	32.12	7.28	HGL Too High!
P13	MH4	MH5	1.20	31.70	31.70	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	32.02	7.09	HGL Too High!
P15	MH5	MH20	1.60	31.31	31.31	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	31.70	7.40	HGL Too High!
P6	DI16	MH2	1.00	32.16	32.16	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.16	7.33	HGL Too High!
P9	DI3	MH3	1.00	32.12	32.12	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.12	6.62	HGL Too High!
P8	DI17	MH3	1.00	32.12	32.12	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.13	6.96	HGL Too High!
P12	DI4	MH4	1.00	32.02	32.02	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	32.03	6.48	HGL Too High!
P11	DI18	MH4	1.00	32.02	32.02	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.03	6.56	HGL Too High!
P14	DI5	MH5	1.00	31.70	31.70	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.71	6.61	HGL Too High!
P18	DI6	MH6	1.00	31.74	31.74	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	31.77	7.13	HGL Too High!
P16	MH6	MH5	1.20	31.70	31.70	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	31.74	7.55	HGL Too High!
P17	DI19	MH6	1.00	31.74	31.74	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	31.75	7.08	HGL Too High!
P32	DI23	MH12	1.00	34.91	34.91	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	34.92	4.24	HGL Too High!
P31	DI9	MH12	1.00	34.91	34.91	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.91	7.13	HGL Too High!
P30	MH12	MH11	1.60	34.88	34.88	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	34.91	7.48	HGL Too High!
P27	MH11	MH10	1.60	34.74	34.74	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	34.88	7.21	HGL Too High!
P25	MH10	MH9	1.60	34.70	34.70	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	34.74	7.54	HGL Too High!
P22	MH9	MH8	1.60	34.59	34.59	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	34.70	7.85	HGL Too High!
P20	MH8	MH21	1.60	34.48	34.48	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	34.59	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	34.39	34.39	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	34.48	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	34.39	34.39	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	34.46	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	34.59	34.59	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	34.64	7.34	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	34.95	34.95	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	35.34	4.78	HGL Too High!
P51	STUB	DI22	1.00	34.95	34.95	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	35.01	7.16	HGL Too High!
P28	DI22	MH11	1.00	34.88	34.88	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	34.95	6.74	HGL Too High!
P29	DI8	MH11	1.00	34.88	34.88	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.88	6.92	HGL Too High!
P26	DI21	MH10	1.00	34.74	34.74	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.75	7.23	HGL Too High!
P23	DI20	MH9	1.00	34.70	34.70	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	34.70	7.38	HGL Too High!
P24	DI7	MH9	1.00	34.70	34.70	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	34.70	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	93.00	93.00	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	93.01	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	93.00	93.00	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	93.02	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	92.78	92.78	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	93.00	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	92.49	92.49	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	92.78	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	91.12	91.12	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	92.49	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	90.23	90.23	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	91.12	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	71.39	71.39	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	90.23	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	58.70	58.70	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	71.39	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	37.08	37.08	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	58.70	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	34.39	34.39	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	37.08	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	31.31	31.31	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	34.39	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	30.04	30.04	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	31.31	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	20.11	20.11	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	30.04	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.05	13.05	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	20.11	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.44**	**9.44**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**13.05**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	95.66	95.66	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	107.74	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	95.66	95.66	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	95.71	6.45	HGL Too High!
P3	DI14	DI13	1.00	95.66	95.66	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	95.68	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	92.78	92.78	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	95.66	6.58	HGL Too High!
P2	DI2	DI1	1.00	92.51	92.51	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	92.52	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	92.49	92.49	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	92.51	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	96.90	96.90	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	96.92	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	96.90	96.90	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	99.23	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	90.23	90.23	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	96.90	8.13	HGL Too High!
P42	DI31	MH22	1.00	72.83	72.83	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	72.92	5.12	HGL Too High!
P43	MH22	DI32	1.00	72.75	72.75	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	72.83	5.45	HGL Too High!
P44	DI32	EX	1.00	71.39	71.39	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	72.75	5.23	HGL Too High!
P46	DI34	DI33	1.00	72.92	72.92	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	72.92	5.47	HGL Too High!
P45	DI33	DI32	1.00	72.75	72.75	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	72.92	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	37.08	37.08	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	37.08	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	90.84	90.84	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	91.10	3.63	HGL Too High!
P48	DI40	DI41	0.80	90.84	90.84	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	90.87	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	90.23	90.23	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	90.84	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	32.68	32.68	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.69	7.41	
P5	MH1	MH2	1.20	32.66	32.66	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	32.68	7.93	HGL Too High!
P7	MH2	MH3	1.20	32.62	32.62	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	32.66	7.65	HGL Too High!
P10	MH3	MH4	1.20	32.52	32.52	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	32.62	7.28	HGL Too High!
P13	MH4	MH5	1.20	32.20	32.20	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	32.52	7.09	HGL Too High!
P15	MH5	MH20	1.60	31.81	31.81	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	32.20	7.40	HGL Too High!
P6	DI16	MH2	1.00	32.66	32.66	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.66	7.33	HGL Too High!
P9	DI3	MH3	1.00	32.62	32.62	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.62	6.62	HGL Too High!
P8	DI17	MH3	1.00	32.62	32.62	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.63	6.96	HGL Too High!
P12	DI4	MH4	1.00	32.52	32.52	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	32.53	6.48	HGL Too High!
P11	DI18	MH4	1.00	32.52	32.52	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.53	6.56	HGL Too High!
P14	DI5	MH5	1.00	32.20	32.20	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.21	6.61	HGL Too High!
P18	DI6	MH6	1.00	32.24	32.24	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	32.27	7.13	HGL Too High!
P16	MH6	MH5	1.20	32.20	32.20	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	32.24	7.55	HGL Too High!
P17	DI19	MH6	1.00	32.24	32.24	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.25	7.08	HGL Too High!
P32	DI23	MH12	1.00	35.41	35.41	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	35.42	4.24	HGL Too High!
P31	DI9	MH12	1.00	35.41	35.41	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	35.41	7.13	HGL Too High!
P30	MH12	MH11	1.60	35.38	35.38	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	35.41	7.48	HGL Too High!
P27	MH11	MH10	1.60	35.24	35.24	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	35.38	7.21	HGL Too High!
P25	MH10	MH9	1.60	35.20	35.20	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	35.24	7.54	HGL Too High!
P22	MH9	MH8	1.60	35.09	35.09	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	35.20	7.85	HGL Too High!
P20	MH8	MH21	1.60	34.98	34.98	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	35.09	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	34.89	34.89	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	34.98	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	34.89	34.89	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	34.96	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	35.09	35.09	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	35.14	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	35.45	35.45	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	35.84	4.78	HGL Too High!
P51	STUB	DI22	1.00	35.45	35.45	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	35.51	7.16	HGL Too High!
P28	DI22	MH11	1.00	35.38	35.38	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	35.45	6.74	HGL Too High!
P29	DI8	MH11	1.00	35.38	35.38	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	35.38	6.92	HGL Too High!
P26	DI21	MH10	1.00	35.24	35.24	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	35.25	7.23	HGL Too High!
P23	DI20	MH9	1.00	35.20	35.20	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	35.20	7.38	HGL Too High!
P24	DI7	MH9	1.00	35.20	35.20	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	35.20	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	93.50	93.50	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	93.51	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	93.50	93.50	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	93.52	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	93.28	93.28	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	93.50	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	92.99	92.99	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	93.28	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	91.62	91.62	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	92.99	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	90.73	90.73	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	91.62	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	71.89	71.89	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	90.73	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	59.20	59.20	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	71.89	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	37.58	37.58	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	59.20	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	34.89	34.89	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	37.58	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	31.81	31.81	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	34.89	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	30.54	30.54	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	31.81	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	20.61	20.61	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	30.54	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.55	13.55	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	20.61	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**9.94**	**9.94**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**13.55**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	96.16	96.16	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	108.24	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	96.16	96.16	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	96.21	6.45	HGL Too High!
P3	DI14	DI13	1.00	96.16	96.16	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	96.18	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	93.28	93.28	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	96.16	6.58	HGL Too High!
P2	DI2	DI1	1.00	93.01	93.01	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	93.02	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	92.99	92.99	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	93.01	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	97.40	97.40	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	97.42	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	97.40	97.40	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	99.73	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	90.73	90.73	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	97.40	8.13	HGL Too High!
P42	DI31	MH22	1.00	73.33	73.33	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	73.42	5.12	HGL Too High!
P43	MH22	DI32	1.00	73.25	73.25	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	73.33	5.45	HGL Too High!
P44	DI32	EX	1.00	71.89	71.89	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	73.25	5.23	HGL Too High!
P46	DI34	DI33	1.00	73.42	73.42	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	73.42	5.47	HGL Too High!
P45	DI33	DI32	1.00	73.25	73.25	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	73.42	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	37.58	37.58	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	37.58	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	91.34	91.34	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	91.60	3.63	HGL Too High!
P48	DI40	DI41	0.80	91.34	91.34	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	91.37	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	90.73	90.73	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	91.34	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	33.08	33.08	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.09	7.41	
P5	MH1	MH2	1.20	33.06	33.06	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	33.08	7.93	HGL Too High!
P7	MH2	MH3	1.20	33.02	33.02	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	33.06	7.65	HGL Too High!
P10	MH3	MH4	1.20	32.92	32.92	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	33.02	7.28	HGL Too High!
P13	MH4	MH5	1.20	32.60	32.60	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	32.92	7.09	HGL Too High!
P15	MH5	MH20	1.60	32.21	32.21	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	32.60	7.40	HGL Too High!
P6	DI16	MH2	1.00	33.06	33.06	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.06	7.33	HGL Too High!
P9	DI3	MH3	1.00	33.02	33.02	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.02	6.62	HGL Too High!
P8	DI17	MH3	1.00	33.02	33.02	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.03	6.96	HGL Too High!
P12	DI4	MH4	1.00	32.92	32.92	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	32.93	6.48	HGL Too High!
P11	DI18	MH4	1.00	32.92	32.92	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.93	6.56	HGL Too High!
P14	DI5	MH5	1.00	32.60	32.60	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.61	6.61	HGL Too High!
P18	DI6	MH6	1.00	32.64	32.64	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	32.67	7.13	HGL Too High!
P16	MH6	MH5	1.20	32.60	32.60	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	32.64	7.55	HGL Too High!
P17	DI19	MH6	1.00	32.64	32.64	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	32.65	7.08	HGL Too High!
P32	DI23	MH12	1.00	35.81	35.81	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	35.82	4.24	HGL Too High!
P31	DI9	MH12	1.00	35.81	35.81	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	35.81	7.13	HGL Too High!
P30	MH12	MH11	1.60	35.78	35.78	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	35.81	7.48	HGL Too High!
P27	MH11	MH10	1.60	35.64	35.64	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	35.78	7.21	HGL Too High!
P25	MH10	MH9	1.60	35.60	35.60	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	35.64	7.54	HGL Too High!
P22	MH9	MH8	1.60	35.49	35.49	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	35.60	7.85	HGL Too High!
P20	MH8	MH21	1.60	35.38	35.38	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	35.49	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	35.29	35.29	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	35.38	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	35.29	35.29	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	35.36	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	35.49	35.49	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	35.54	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	35.85	35.85	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	36.24	4.78	HGL Too High!
P51	STUB	DI22	1.00	35.85	35.85	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	35.91	7.16	HGL Too High!
P28	DI22	MH11	1.00	35.78	35.78	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	35.85	6.74	HGL Too High!
P29	DI8	MH11	1.00	35.78	35.78	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	35.78	6.92	HGL Too High!
P26	DI21	MH10	1.00	35.64	35.64	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	35.65	7.23	HGL Too High!
P23	DI20	MH9	1.00	35.60	35.60	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	35.60	7.38	HGL Too High!
P24	DI7	MH9	1.00	35.60	35.60	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	35.60	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	93.90	93.90	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	93.91	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	93.90	93.90	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	93.92	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	93.68	93.68	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	93.90	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	93.39	93.39	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	93.68	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	92.02	92.02	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	93.39	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	91.13	91.13	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	92.02	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	72.29	72.29	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	91.13	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	59.60	59.60	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	72.29	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	37.98	37.98	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	59.60	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	35.29	35.29	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	37.98	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	32.21	32.21	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	35.29	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	30.94	30.94	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	32.21	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	21.01	21.01	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	30.94	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	13.95	13.95	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	21.01	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.34**	**10.34**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**13.95**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	96.56	96.56	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	108.64	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	96.56	96.56	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	96.61	6.45	HGL Too High!
P3	DI14	DI13	1.00	96.56	96.56	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	96.58	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	93.68	93.68	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	96.56	6.58	HGL Too High!
P2	DI2	DI1	1.00	93.41	93.41	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	93.42	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	93.39	93.39	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	93.41	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	97.80	97.80	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	97.82	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	97.80	97.80	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	100.13	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	91.13	91.13	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	97.80	8.13	HGL Too High!
P42	DI31	MH22	1.00	73.73	73.73	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	73.82	5.12	HGL Too High!
P43	MH22	DI32	1.00	73.65	73.65	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	73.73	5.45	HGL Too High!
P44	DI32	EX	1.00	72.29	72.29	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	73.65	5.23	HGL Too High!
P46	DI34	DI33	1.00	73.82	73.82	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	73.82	5.47	HGL Too High!
P45	DI33	DI32	1.00	73.65	73.65	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	73.82	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	37.98	37.98	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	37.98	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	91.74	91.74	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	92.00	3.63	HGL Too High!
P48	DI40	DI41	0.80	91.74	91.74	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	91.77	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	91.13	91.13	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	91.74	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	33.58	33.58	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.59	7.41	
P5	MH1	MH2	1.20	33.56	33.56	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	33.58	7.93	HGL Too High!
P7	MH2	MH3	1.20	33.52	33.52	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	33.56	7.65	HGL Too High!
P10	MH3	MH4	1.20	33.42	33.42	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	33.52	7.28	HGL Too High!
P13	MH4	MH5	1.20	33.10	33.10	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	33.42	7.09	HGL Too High!
P15	MH5	MH20	1.60	32.71	32.71	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	33.10	7.40	HGL Too High!
P6	DI16	MH2	1.00	33.56	33.56	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.56	7.33	HGL Too High!
P9	DI3	MH3	1.00	33.52	33.52	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.52	6.62	HGL Too High!
P8	DI17	MH3	1.00	33.52	33.52	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.53	6.96	HGL Too High!
P12	DI4	MH4	1.00	33.42	33.42	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	33.43	6.48	HGL Too High!
P11	DI18	MH4	1.00	33.42	33.42	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.43	6.56	HGL Too High!
P14	DI5	MH5	1.00	33.10	33.10	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.11	6.61	HGL Too High!
P18	DI6	MH6	1.00	33.14	33.14	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	33.17	7.13	HGL Too High!
P16	MH6	MH5	1.20	33.10	33.10	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	33.14	7.55	HGL Too High!
P17	DI19	MH6	1.00	33.14	33.14	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.15	7.08	HGL Too High!
P32	DI23	MH12	1.00	36.31	36.31	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	36.32	4.24	HGL Too High!
P31	DI9	MH12	1.00	36.31	36.31	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	36.31	7.13	HGL Too High!
P30	MH12	MH11	1.60	36.28	36.28	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	36.31	7.48	HGL Too High!
P27	MH11	MH10	1.60	36.14	36.14	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	36.28	7.21	HGL Too High!
P25	MH10	MH9	1.60	36.10	36.10	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	36.14	7.54	HGL Too High!
P22	MH9	MH8	1.60	35.99	35.99	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	36.10	7.85	HGL Too High!
P20	MH8	MH21	1.60	35.88	35.88	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	35.99	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	35.79	35.79	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	35.88	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	35.79	35.79	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	35.86	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	35.99	35.99	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	36.04	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	36.35	36.35	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	36.74	4.78	HGL Too High!
P51	STUB	DI22	1.00	36.35	36.35	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	36.41	7.16	HGL Too High!
P28	DI22	MH11	1.00	36.28	36.28	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	36.35	6.74	HGL Too High!
P29	DI8	MH11	1.00	36.28	36.28	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	36.28	6.92	HGL Too High!
P26	DI21	MH10	1.00	36.14	36.14	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	36.15	7.23	HGL Too High!
P23	DI20	MH9	1.00	36.10	36.10	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	36.10	7.38	HGL Too High!
P24	DI7	MH9	1.00	36.10	36.10	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	36.10	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	94.40	94.40	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	94.41	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	94.40	94.40	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	94.42	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	94.18	94.18	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	94.40	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	93.89	93.89	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	94.18	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	92.52	92.52	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	93.89	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	91.63	91.63	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	92.52	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	72.79	72.79	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	91.63	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	60.10	60.10	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	72.79	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	38.48	38.48	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	60.10	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	35.79	35.79	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	38.48	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	32.71	32.71	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	35.79	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	31.44	31.44	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	32.71	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	21.51	21.51	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	31.44	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	14.45	14.45	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	21.51	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**10.84**	**10.84**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**14.45**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	97.06	97.06	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	109.14	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	97.06	97.06	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	97.11	6.45	HGL Too High!
P3	DI14	DI13	1.00	97.06	97.06	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	97.08	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	94.18	94.18	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	97.06	6.58	HGL Too High!
P2	DI2	DI1	1.00	93.91	93.91	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	93.92	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	93.89	93.89	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	93.91	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	98.30	98.30	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	98.32	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	98.30	98.30	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	100.63	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	91.63	91.63	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	98.30	8.13	HGL Too High!
P42	DI31	MH22	1.00	74.23	74.23	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	74.32	5.12	HGL Too High!
P43	MH22	DI32	1.00	74.15	74.15	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	74.23	5.45	HGL Too High!
P44	DI32	EX	1.00	72.79	72.79	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	74.15	5.23	HGL Too High!
P46	DI34	DI33	1.00	74.32	74.32	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	74.32	5.47	HGL Too High!
P45	DI33	DI32	1.00	74.15	74.15	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	74.32	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	38.48	38.48	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	38.48	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	92.24	92.24	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	92.50	3.63	HGL Too High!
P48	DI40	DI41	0.80	92.24	92.24	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	92.27	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	91.63	91.63	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	92.24	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	34.28	34.28	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.29	7.41	
P5	MH1	MH2	1.20	34.26	34.26	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	34.28	7.93	HGL Too High!
P7	MH2	MH3	1.20	34.22	34.22	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	34.26	7.65	HGL Too High!
P10	MH3	MH4	1.20	34.12	34.12	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	34.22	7.28	HGL Too High!
P13	MH4	MH5	1.20	33.80	33.80	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	34.12	7.09	HGL Too High!
P15	MH5	MH20	1.60	33.41	33.41	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	33.80	7.40	HGL Too High!
P6	DI16	MH2	1.00	34.26	34.26	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.26	7.33	HGL Too High!
P9	DI3	MH3	1.00	34.22	34.22	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.22	6.62	HGL Too High!
P8	DI17	MH3	1.00	34.22	34.22	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.23	6.96	HGL Too High!
P12	DI4	MH4	1.00	34.12	34.12	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	34.13	6.48	HGL Too High!
P11	DI18	MH4	1.00	34.12	34.12	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.13	6.56	HGL Too High!
P14	DI5	MH5	1.00	33.80	33.80	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.81	6.61	HGL Too High!
P18	DI6	MH6	1.00	33.84	33.84	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	33.87	7.13	HGL Too High!
P16	MH6	MH5	1.20	33.80	33.80	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	33.84	7.55	HGL Too High!
P17	DI19	MH6	1.00	33.84	33.84	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	33.85	7.08	HGL Too High!
P32	DI23	MH12	1.00	37.01	37.01	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	37.02	4.24	HGL Too High!
P31	DI9	MH12	1.00	37.01	37.01	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	37.01	7.13	HGL Too High!
P30	MH12	MH11	1.60	36.98	36.98	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	37.01	7.48	HGL Too High!
P27	MH11	MH10	1.60	36.84	36.84	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	36.98	7.21	HGL Too High!
P25	MH10	MH9	1.60	36.80	36.80	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	36.84	7.54	HGL Too High!
P22	MH9	MH8	1.60	36.69	36.69	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	36.80	7.85	HGL Too High!
P20	MH8	MH21	1.60	36.58	36.58	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	36.69	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	36.49	36.49	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	36.58	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	36.49	36.49	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	36.56	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	36.69	36.69	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	36.74	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	37.05	37.05	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	37.44	4.78	HGL Too High!
P51	STUB	DI22	1.00	37.05	37.05	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	37.11	7.16	HGL Too High!
P28	DI22	MH11	1.00	36.98	36.98	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	37.05	6.74	HGL Too High!
P29	DI8	MH11	1.00	36.98	36.98	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	36.98	6.92	HGL Too High!
P26	DI21	MH10	1.00	36.84	36.84	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	36.85	7.23	HGL Too High!
P23	DI20	MH9	1.00	36.80	36.80	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	36.80	7.38	HGL Too High!
P24	DI7	MH9	1.00	36.80	36.80	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	36.80	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	95.10	95.10	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	95.11	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	95.10	95.10	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	95.12	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	94.88	94.88	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	95.10	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	94.59	94.59	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	94.88	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	93.22	93.22	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	94.59	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	92.33	92.33	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	93.22	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	73.49	73.49	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	92.33	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	60.80	60.80	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	73.49	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	39.18	39.18	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	60.80	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	36.49	36.49	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	39.18	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	33.41	33.41	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	36.49	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	32.14	32.14	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	33.41	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	22.21	22.21	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	32.14	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	15.15	15.15	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	22.21	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**11.54**	**11.54**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**15.15**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	97.76	97.76	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	109.84	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	97.76	97.76	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	97.81	6.45	HGL Too High!
P3	DI14	DI13	1.00	97.76	97.76	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	97.78	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	94.88	94.88	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	97.76	6.58	HGL Too High!
P2	DI2	DI1	1.00	94.61	94.61	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	94.62	6.84	HGL Too High!

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Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	94.59	94.59	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	94.61	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	99.00	99.00	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	99.02	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	99.00	99.00	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	101.33	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	92.33	92.33	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	99.00	8.13	HGL Too High!
P42	DI31	MH22	1.00	74.93	74.93	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	75.02	5.12	HGL Too High!
P43	MH22	DI32	1.00	74.85	74.85	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	74.93	5.45	HGL Too High!
P44	DI32	EX	1.00	73.49	73.49	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	74.85	5.23	HGL Too High!
P46	DI34	DI33	1.00	75.02	75.02	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	75.02	5.47	HGL Too High!
P45	DI33	DI32	1.00	74.85	74.85	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	75.02	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	39.18	39.18	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	39.18	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	92.94	92.94	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	93.20	3.63	HGL Too High!
P48	DI40	DI41	0.80	92.94	92.94	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	92.97	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	92.33	92.33	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	92.94	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	34.78	34.78	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.79	7.41	
P5	MH1	MH2	1.20	34.76	34.76	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	34.78	7.93	HGL Too High!
P7	MH2	MH3	1.20	34.72	34.72	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	34.76	7.65	HGL Too High!
P10	MH3	MH4	1.20	34.62	34.62	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	34.72	7.28	HGL Too High!
P13	MH4	MH5	1.20	34.30	34.30	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	34.62	7.09	HGL Too High!
P15	MH5	MH20	1.60	33.91	33.91	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	34.30	7.40	HGL Too High!
P6	DI16	MH2	1.00	34.76	34.76	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.76	7.33	HGL Too High!
P9	DI3	MH3	1.00	34.72	34.72	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.72	6.62	HGL Too High!
P8	DI17	MH3	1.00	34.72	34.72	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.73	6.96	HGL Too High!
P12	DI4	MH4	1.00	34.62	34.62	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	34.63	6.48	HGL Too High!
P11	DI18	MH4	1.00	34.62	34.62	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.63	6.56	HGL Too High!
P14	DI5	MH5	1.00	34.30	34.30	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.31	6.61	HGL Too High!
P18	DI6	MH6	1.00	34.34	34.34	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	34.37	7.13	HGL Too High!
P16	MH6	MH5	1.20	34.30	34.30	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	34.34	7.55	HGL Too High!
P17	DI19	MH6	1.00	34.34	34.34	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	34.35	7.08	HGL Too High!
P32	DI23	MH12	1.00	37.51	37.51	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	37.52	4.24	HGL Too High!
P31	DI9	MH12	1.00	37.51	37.51	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	37.51	7.13	HGL Too High!
P30	MH12	MH11	1.60	37.48	37.48	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	37.51	7.48	HGL Too High!
P27	MH11	MH10	1.60	37.34	37.34	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	37.48	7.21	HGL Too High!
P25	MH10	MH9	1.60	37.30	37.30	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	37.34	7.54	HGL Too High!
P22	MH9	MH8	1.60	37.19	37.19	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	37.30	7.85	HGL Too High!
P20	MH8	MH21	1.60	37.08	37.08	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	37.19	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	36.99	36.99	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	37.08	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	36.99	36.99	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	37.06	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	37.19	37.19	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	37.24	7.34	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	37.55	37.55	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	37.94	4.78	HGL Too High!
P51	STUB	DI22	1.00	37.55	37.55	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	37.61	7.16	HGL Too High!
P28	DI22	MH11	1.00	37.48	37.48	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	37.55	6.74	HGL Too High!
P29	DI8	MH11	1.00	37.48	37.48	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	37.48	6.92	HGL Too High!
P26	DI21	MH10	1.00	37.34	37.34	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	37.35	7.23	HGL Too High!
P23	DI20	MH9	1.00	37.30	37.30	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	37.30	7.38	HGL Too High!
P24	DI7	MH9	1.00	37.30	37.30	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	37.30	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	95.60	95.60	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	95.61	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	95.60	95.60	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	95.62	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	95.38	95.38	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	95.60	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	95.09	95.09	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	95.38	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	93.72	93.72	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	95.09	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	92.83	92.83	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	93.72	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	73.99	73.99	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	92.83	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	61.30	61.30	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	73.99	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	39.68	39.68	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	61.30	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	36.99	36.99	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	39.68	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	33.91	33.91	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	36.99	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	32.64	32.64	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	33.91	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	22.71	22.71	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	32.64	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	15.65	15.65	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	22.71	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**12.04**	**12.04**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**15.65**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	98.26	98.26	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	110.34	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	98.26	98.26	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	98.31	6.45	HGL Too High!
P3	DI14	DI13	1.00	98.26	98.26	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	98.28	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	95.38	95.38	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	98.26	6.58	HGL Too High!
P2	DI2	DI1	1.00	95.11	95.11	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	95.12	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	95.09	95.09	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	95.11	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	99.50	99.50	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	99.52	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	99.50	99.50	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	101.83	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	92.83	92.83	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	99.50	8.13	HGL Too High!
P42	DI31	MH22	1.00	75.43	75.43	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	75.52	5.12	HGL Too High!
P43	MH22	DI32	1.00	75.35	75.35	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	75.43	5.45	HGL Too High!
P44	DI32	EX	1.00	73.99	73.99	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	75.35	5.23	HGL Too High!
P46	DI34	DI33	1.00	75.52	75.52	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	75.52	5.47	HGL Too High!
P45	DI33	DI32	1.00	75.35	75.35	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	75.52	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	39.68	39.68	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	39.68	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	93.44	93.44	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	93.70	3.63	HGL Too High!
P48	DI40	DI41	0.80	93.44	93.44	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	93.47	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	92.83	92.83	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	93.44	4.62	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P4	DI15	MH1	1.00	36.08	36.08	15	0.8	0.7	90	27.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	36.09	7.41	
P5	MH1	MH2	1.20	36.06	36.06	18	1.6	0.9	0	82.7	0.0002	0.02	0	0.00	0.00	0.5	0.0	0.0	0.7	0.0	90	0.00	0.01	1.3	0.5	0.01	0.02	36.08	7.93	HGL Too High!
P7	MH2	MH3	1.20	36.02	36.02	18	2.4	1.4	1	73.8	0.0005	0.03	0	0.00	0.01	1.5	0.6	0.0	0.9	0.0	0	0.00	0.01	1.0	0.5	0.01	0.04	36.06	7.65	HGL Too High!
P10	MH3	MH4	1.20	35.92	35.92	18	4.4	2.5	8	53.7	0.0015	0.08	0	0.00	0.02	3.3	1.0	0.8	1.4	0.0	1	0.00	0.03	1.0	0.5	0.02	0.10	36.02	7.28	HGL Too High!
P13	MH4	MH5	1.20	35.60	35.60	18	7.6	4.3	84	59.3	0.0044	0.26	0	0.00	0.07	11.0	1.6	1.3	2.5	0.0	8	0.01	0.11	1.0	0.5	0.06	0.32	35.92	7.09	HGL Too High!
P15	MH5	MH20	1.60	35.21	35.21	24	11.3	3.6	90	104	0.0021	0.22	0	0.00	0.05	32.3	4.4	1.3	4.3	0.1	84	0.19	0.34	1.0	0.5	0.17	0.39	35.60	7.40	HGL Too High!
P6	DI16	MH2	1.00	36.06	36.06	15	0.8	0.7	86	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	36.06	7.33	HGL Too High!
P9	DI3	MH3	1.00	36.02	36.02	15	1.1	0.9	87	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	36.02	6.62	HGL Too High!
P8	DI17	MH3	1.00	36.02	36.02	15	1.0	0.8	81	31.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	36.03	6.96	HGL Too High!
P12	DI4	MH4	1.00	35.92	35.92	15	1.4	1.1	99	20.1	0.0004	0.01	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.01	35.93	6.48	HGL Too High!
P11	DI18	MH4	1.00	35.92	35.92	15	1.3	1.0	86	28.4	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	35.93	6.56	HGL Too High!
P14	DI5	MH5	1.00	35.60	35.60	15	1.3	1.0	21	22.6	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	35.61	6.61	HGL Too High!
P18	DI6	MH6	1.00	35.64	35.64	15	1.7	1.4	23	38	0.0006	0.02	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.03	35.67	7.13	HGL Too High!
P16	MH6	MH5	1.20	35.60	35.60	18	2.8	1.6	86	40	0.0006	0.02	0	0.00	0.01	2.3	1.0	0.0	1.4	0.0	23	0.01	0.03	1.0	0.5	0.01	0.04	35.64	7.55	HGL Too High!
P17	DI19	MH6	1.00	35.64	35.64	15	1.1	0.9	94	33	0.0003	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	35.65	7.08	HGL Too High!
P32	DI23	MH12	1.00	38.81	38.81	15	1.4	1.1	64	33.3	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	38.82	4.24	HGL Too High!
P31	DI9	MH12	1.00	38.81	38.81	15	1.0	0.8	90	18.3	0.0002	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	38.81	7.13	HGL Too High!
P30	MH12	MH11	1.60	38.78	38.78	24	2.3	0.7	1	50.1	0.0004	0.02	0	0.00	0.00	0.8	1.5	0.0	1.1	0.0	64	0.01	0.02	1.0	0.5	0.01	0.03	38.81	7.48	HGL Too High!
P27	MH11	MH10	1.60	38.64	38.64	24	4.7	1.5	5	73.2	0.0017	0.13	0	0.00	0.01	1.7	1.5	1.0	0.7	0.0	1	0.00	0.01	1.0	0.5	0.01	0.13	38.78	7.21	HGL Too High!
P25	MH10	MH9	1.60	38.60	38.60	24	5.4	1.7	5	69.7	0.0005	0.03	0	0.00	0.01	7.2	0.4	0.0	1.5	0.0	5	0.00	0.03	1.0	0.5	0.01	0.05	38.64	7.54	HGL Too High!
P22	MH9	MH8	1.60	38.49	38.49	24	6.7	2.1	51	108	0.0008	0.08	0	0.00	0.02	9.2	0.5	0.4	1.7	0.0	5	0.00	0.04	1.0	0.5	0.02	0.10	38.60	7.85	HGL Too High!
P20	MH8	MH21	1.60	38.38	38.38	24	8.5	2.7	90	57.3	0.0012	0.07	0	0.00	0.03	14.5	3.1	0.0	2.1	0.0	51	0.04	0.09	1.0	0.5	0.04	0.11	38.49	8.04	HGL Too High!
P21	MH21	EXMH1	1.60	38.29	38.29	24	8.5	2.7	21	11.3	0.0012	0.01	0	0.00	0.03	23.0	0.0	0.0	2.7	0.0	90	0.08	0.15	1.0	0.5	0.07	0.09	38.38	5.83	HGL Too High!
P47	DI35	EXMH1	1.20	38.29	38.29	18	5.9	3.3	35	7.75	0.0026	0.02	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	26	0.00	0.04	1.0	1.0	0.04	0.06	38.36	2.78	HGL Too High!
P-80	DI-80	MH-08	1.00	38.49	38.49	15	1.9	1.6	35	49	0.0008	0.04	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	26	0.00	0.01	1.0	1.0	0.01	0.05	38.54	7.34	HGL Too High!

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Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_f + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P52	TDI50	DI22	0.53	38.85	38.85	8	1.7	4.9	45	17	0.0173	0.29	0	0.00	0.09	0.0	0.0	0.0	0.0	0.0	0	0.00	0.09	1.0	1.0	0.09	0.39	39.24	4.78	HGL Too High!
P51	STUB	DI22	1.00	38.85	38.85	15	4.2	3.4	0	10	0.0035	0.04	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	0.5	0.02	0.06	38.91	7.16	HGL Too High!
P28	DI22	MH11	1.00	38.78	38.78	15	1.4	1.1	90	30.3	0.0004	0.01	0	0.00	0.00	14.1	8.5	0.0	3.4	0.1	0	0.00	0.07	1.0	1.0	0.07	0.08	38.85	6.74	HGL Too High!
P29	DI8	MH11	1.00	38.78	38.78	15	1.1	0.9	90	18.3	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	38.78	6.92	HGL Too High!
P26	DI21	MH10	1.00	38.64	38.64	15	0.7	0.6	93	18.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	38.65	7.23	HGL Too High!
P23	DI20	MH9	1.00	38.60	38.60	15	0.8	0.6	85	29.3	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	85	0.00	0.00	1.0	1.0	0.00	0.01	38.60	7.38	HGL Too High!
P24	DI7	MH9	1.00	38.60	38.60	15	0.7	0.6	47	28	0.0001	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	38.60	7.48	HGL Too High!
CRB-P72	CRB-DI72	CRB-MH-74	1.00	96.90	96.90	15	1.2	1.0	90	16	0.0003	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	96.91	5.78	HGL Too High!
CRB-P73	CRB-DI73	CRB-MH-74	1.00	96.90	96.90	15	1.4	1.1	90	34	0.0004	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.02	96.92	5.54	HGL Too High!
CRB-P74	CRB-MH-74	CRB-MH-67	1.00	96.68	96.68	15	2.5	2.1	90	154	0.0013	0.20	0	0.00	0.02	1.2	1.5	0.0	1.1	0.0	90	0.01	0.04	1.0	0.5	0.02	0.22	96.90	6.04	HGL Too High!
EXP2	CRB-MH-67	EXMH3	1.00	96.39	96.39	15	6.2	5.1	90	23	0.0093	0.21	0	0.00	0.10	5.3	11.8	0.0	3.1	0.1	0	0.00	0.15	1.0	0.5	0.08	0.29	96.68	7.04	HGL Too High!
EXP3	EXMH3	EXMH4	1.00	95.02	95.02	15	7.6	6.2	0	78	0.0139	1.08	0	0.00	0.15	31.5	1.8	0.0	5.1	0.1	90	0.28	0.57	1.0	0.5	0.28	1.37	96.39	6.67	HGL Too High!
EXP4	EXMH4	EXMH5	1.00	94.13	94.13	15	7.4	6.0	0	54	0.0132	0.71	0	0.00	0.14	47.3	0.0	0.0	6.2	0.2	0	0.00	0.35	1.0	0.5	0.18	0.89	95.02	7.20	HGL Too High!
EXP5	EXMH5	EXMH6	1.00	75.29	75.29	15	16.6	13.6	0	263	0.0663	17.44	0	0.00	0.71	44.7	70.4	18.8	11.4	0.7	90	1.40	2.82	1.0	0.5	1.41	18.85	94.13	7.56	HGL Too High!
EXP6	EXMH6	EXMH7	1.00	62.60	62.60	15	22.4	18.3	0	96	0.1202	11.54	0	0.00	1.29	225.4	62.5	0.0	13.6	1.0	0	0.00	2.29	1.0	0.5	1.15	12.69	75.29	7.21	HGL Too High!
EXP7	EXMH7	EXMH8	1.00	40.98	40.98	15	21.9	17.8	60	175	0.1148	20.10	0	0.00	1.24	408.7	0.0	0.0	18.3	1.8	0	0.00	3.05	1.0	0.5	1.52	21.62	62.60	6.74	HGL Too High!
EXP8	EXMH8	EXMH9	1.60	38.29	38.29	24	21.0	6.7	84	41	0.0086	0.35	0	0.00	0.17	390.5	0.0	0.0	17.8	1.7	60	2.77	4.67	1.0	0.5	2.33	2.69	40.98	7.99	HGL Too High!
EXP9	EXMH9	EXMH10	1.60	35.21	35.21	24	32.3	10.3	13	124	0.0204	2.53	0	0.00	0.41	139.8	22.8	19.4	6.7	0.2	84	0.47	1.12	1.0	0.5	0.56	3.09	38.29	4.71	HGL Too High!
EXP10	EXMH10	EXMH11	1.60	33.94	33.94	24	41.0	13.0	78	8	0.0328	0.26	0	0.00	0.66	331.9	0.0	0.0	10.3	0.6	13	0.31	1.55	1.3	0.5	1.00	1.27	35.21	5.47	HGL Too High!
EXP11	EXMH11	EXMH12	1.60	24.01	24.01	24	41.0	13.0	0	252	0.0328	8.26	0	0.00	0.66	534.1	0.0	0.0	13.0	0.9	78	1.74	3.33	1.0	0.5	1.66	9.93	33.94	5.86	HGL Too High!
EXP12	EXMH12	EXMH13	1.60	16.95	16.95	24	38.2	12.2	25	221	0.0286	6.31	0	0.00	0.58	534.1	0.0	0.0	13.0	0.9	0	0.00	1.50	1.0	0.5	0.75	7.06	24.01	5.94	HGL Too High!
EXP13	**EXMH13**	**OUTFALL**	**1.60**	**13.34**	**13.34**	**24**	**36.8**	**11.7**	**0**	**98**	**0.0265**	**2.60**	**0**	**0.00**	**0.53**	**465.4**	**0.0**	**0.0**	**12.2**	**0.8**	**25**	**0.69**	**2.03**	**1.0**	**0.5**	**1.01**	**3.61**	**16.95**	**7.80**	**HGL Too High**
ROOF	COLLINS	MSS DI-13	0.27	99.56	99.56	4	1.7	19.9	0	16	0.7069	11.31	0	0.00	1.53	0.0	0.0	0.0	0.0	0.0	0	0.00	1.53	1.0	0.5	0.77	12.08	111.64	6.37	HGL Too High!
CRB-P75	TD-03	MSS DI-13	0.53	99.56	99.56	8	0.5	1.3	90	33	0.0010	0.03	0	0.00	0.01	0.0	0.0	0.0	0.0	0.0	0	0.00	0.01	1.0	1.0	0.01	0.04	99.61	6.45	HGL Too High!
P3	DI14	DI13	1.00	99.56	99.56	15	0.8	0.7	90	69.3	0.0001	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	99.58	7.30	HGL Too High!
EXP1	DI13	MH67	1.00	96.68	96.68	15	3.8	3.1	0	15	0.0035	0.05	0	0.00	0.04	0.6	34.4	0.6	19.9	2.1	0	0.00	2.18	1.3	1.0	2.84	2.89	99.56	6.58	HGL Too High!
P2	DI2	DI1	1.00	96.41	96.41	15	0.9	0.8	70	69.3	0.0002	0.01	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.01	96.42	6.84	HGL Too High!

Delaware Department of Transportation
Hydraulic Grade Line Computations

Project:	South Market Street Infrastructure Improvements	Prepared by:	RKK	Design Date:	2/23/23	Sheet No.:	of
County:	New Castle	Checked by:	RKK	Model Date:	3/23/23	Cm. No.:	20077
Segment:	Market Street Existing Conditions 24" Outfall	Design Freq.:	500	-year (50-year for sumps)			

Location			Minimum Starting Depth, (dc+D)/2 or 0.8D	Tailwater, link to Inlet WSE of downstream pipe	Outlet W. S. Elevation	Outflow Pipe Diameter	Outflow Pipe Design Flow	Pressure-flow Vel., $V_o=Q_o/A$	Skew angle vs. downstrm. pipe	Outflow Pipe Length	Friction Slope	Friction Loss	Angle of Curvatu	Curved align; add Hc =	Contraction Loss	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Q V for determining controlling inflow pipe	Controlling Inflow Velocity	Expansion Loss	Controlling In-flow skew	Bend Loss	Total Jct. Loss, $H_t = H_o + H_i + H_\Delta$	Coefficient for inlet of >10% mainline Q	Coeff for MH or JB (1.0 for inlet, 0.5 for MH or JB shaping)	Adjusted Junction Loss	Tot. H Loss, $H = H_f + H_{t\,adj}$	Inlet W. S. Elevation	Top of Grate	HGL Check
No.	From	To	0.8D	TW	HGL Dn	D_o	Q_o	V_o	Δ_o	L	S_{fo}	H_f	O	H_c	H_o	Q1V1	Q2V2	Q3V3	Vi	Hi	Δ_i	H_Δ	H_t			$H_{t\,adj}$	H	HGL Up	T/G	
			ft	ft	ft	in	cfs	fps	deg	ft	ft/ft	ft	deg	ft	ft	ft^4/s^2	ft^4/s^2	ft^4/s^2		ft	deg	ft	cfs			ft	ft	ft	ft	
P1	DI1	EXMH	1.00	96.39	96.39	15	1.5	1.2	111	3.34	0.0005	0.00	0	0.00	0.01	0.7	0.0	0.0	0.8	0.0	70	0.01	0.01	1.3	1.0	0.02	0.02	96.41	6.45	HGL Too High!
CRB-P84	TD-04	EXMH	0.53	100.80	100.80	8	0.3	0.9	104	46	0.0005	0.02	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	100.82	7.39	HGL Too High!
EXP15	EXDI	EXMH	0.80	100.80	100.80	12	6.0	7.7	90	87	0.0243	2.11	0	0.00	0.23	0.0	0.0	0.0	0.0	0.0	0	0.00	0.23	1.0	1.0	0.23	2.34	103.13	4.53	HGL Too High!
EXP16	EXMH	EXMH5	0.67	94.13	94.13	10	6.2	11.4	90	87	0.0682	5.93	0	0.00	0.50	46.0	0.3	0.0	7.7	0.3	90	0.64	1.46	1.0	0.5	0.73	6.66	100.80	8.13	HGL Too High!
P42	DI31	MH22	1.00	76.73	76.73	15	2.5	2.0	7.5	55.8	0.0013	0.07	0	0.00	0.02	0.0	0.0	0.0	0.0	0.0	0	0.00	0.02	1.0	1.0	0.02	0.09	76.82	5.12	HGL Too High!
P43	MH22	DI32	1.00	76.65	76.65	15	2.5	2.0	80	45.1	0.0013	0.06	0	0.00	0.02	5.1	0.0	0.0	2.0	0.0	7.5	0.01	0.04	1.0	0.5	0.02	0.08	76.73	5.45	HGL Too High!
P44	DI32	EX	1.00	75.29	75.29	15	8.8	7.1	90	59.3	0.0157	0.93	0	0.00	0.20	5.0	10.2	0.0	2.9	0.0	94	0.09	0.33	1.3	1.0	0.43	1.36	76.65	5.23	HGL Too High!
P46	DI34	DI33	1.00	76.82	76.82	15	0.5	0.4	19	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.00	76.82	5.47	HGL Too High!
P45	DI33	DI32	1.00	76.65	76.65	15	3.5	2.9	94	48.5	0.0026	0.12	0	0.00	0.03	0.2	0.0	0.0	0.4	0.0	19	0.00	0.03	1.3	1.0	0.04	0.17	76.82	5.45	HGL Too High!
EXP17	EXMH	EXMH8	1.00	40.98	40.98	15	0.0	0.0	0	36.9	0.0000	0.00	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	0.5	0.00	0.00	40.98	7.48	HGL Too High!
EX-P LOT	EXDI LOT	DI-MSS-41	0.80	94.74	94.74	12	2.6	3.3	0	47	0.0046	0.22	0	0.00	0.04	0.0	0.0	0.0	0.0	0.0	0	0.00	0.04	1.0	1.0	0.04	0.26	95.00	3.63	HGL Too High!
P48	DI40	DI41	0.80	94.74	94.74	12	0.7	0.9	90	82.1	0.0003	0.03	0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0	0.00	0.00	1.0	1.0	0.00	0.03	94.77	4.70	HGL Too High!
P-MSS-48A	DI-MSS-41	EX-MH LOW	0.80	94.13	94.13	12	3.8	4.9	95	41	0.0099	0.41	0	0.00	0.09	0.6	8.8	0.0	3.3	0.1	0	0.00	0.15	1.3	1.0	0.20	0.60	94.74	4.62	HGL Too High!