

**HYDRAULIC ANALYSIS FOR THE
SEWER CONNECTION FROM THE
CHAMPLIN HILLS AND
CHAMPLIN HEIGHTS
RESIDENTIAL DEVELOPMENTS**

**CITY OF CRANSTON
VEOLIA WATER NORTH AMERICA**

MEMORANDUM

Prepared for
Veolia Water North America
Cranston RI



May 14, 2015

Prepared by
Stantec Consulting Services Inc.
Westford MA



To: John Ayotte
Veolia Water North America

From: John Murphy
Westford, MA

File: 195110343

Date: May 14, 2015

Reference: Sewer System Connection Hydraulic Analysis for the Proposed Champlin Hills and Champlin Heights Residential Developments

BACKGROUND

Stantec has been retained by Veolia Water NA in Cranston to evaluate the impacts on the Cranston sewer system of the proposed Champlin Hills and Champlin Heights multi-unit residential developments located off Scituate Avenue in Northwestern Cranston. The Champlin Hills development consists of 63 2-bedroom dwelling units on Assessors Plat 20-4, Lot 2117. The Champlin development consists of 150 2-bedroom dwelling units on Assessors Plat 20-4, Lot 2128 and Assessors Plat 12-6, Lot 3108. The 2 residential developments propose to connect their sewage flows to the Cranston sewer system with the Champlin Hills development connecting to sewer manhole SMH6465 and Champlin Heights to sewer manhole SMH6467.

The proposed sewage flows from the site were evaluated to determine if their addition to the existing flows would exceed the capacity of the sewer system from the connection to the sewer system on Scituate Avenue to the discharge point at the Sherman Avenue Pump Station off Sherman Avenue through approximately 12,300 feet of interconnecting sewers. The analysis also reviewed the capacity of the pump station to accommodate the increased flow. **Figure 1** shows the location of the developments and the alignment of the sewers to be affected by the proposed developments.

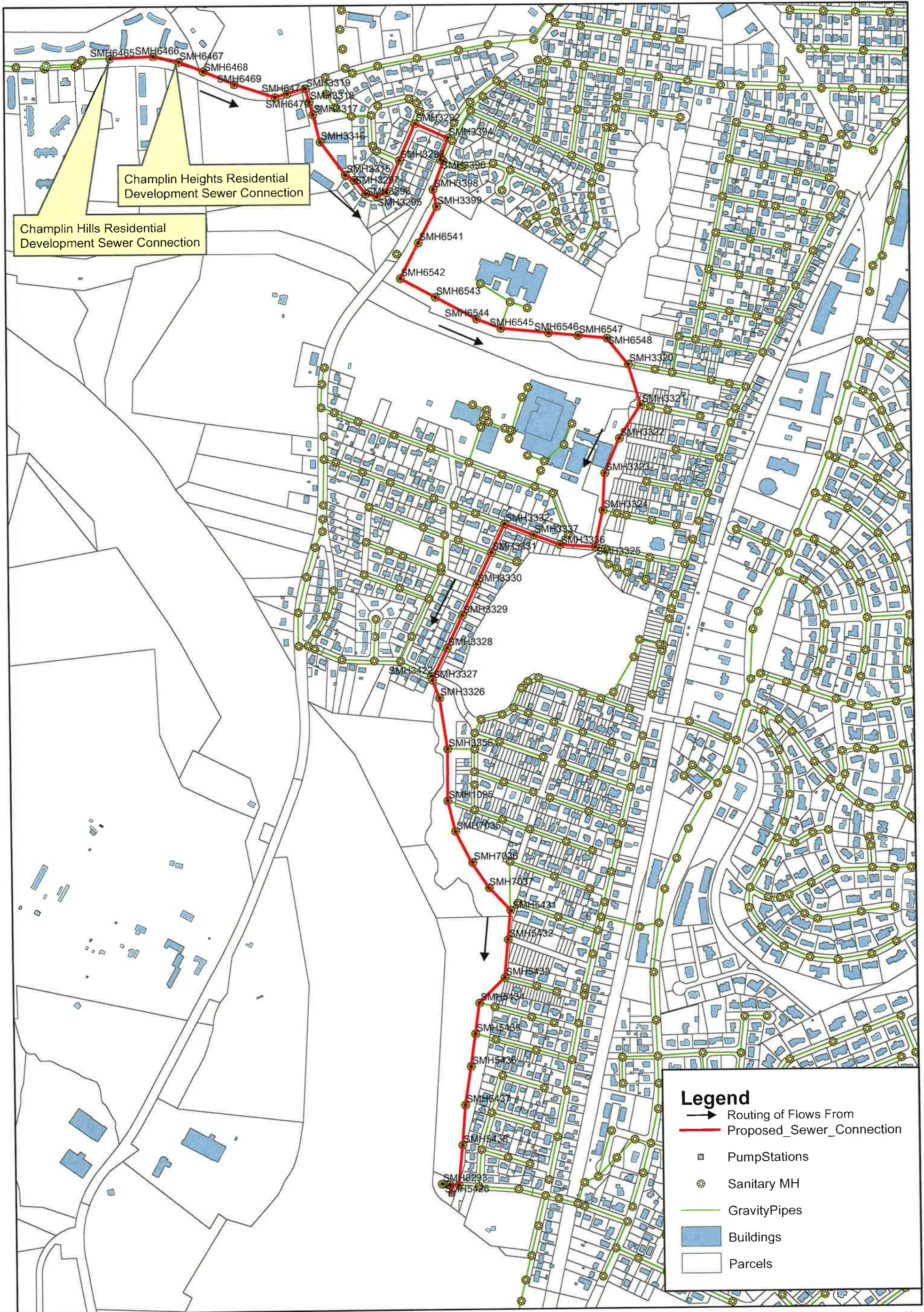
As requested by Veolia, we evaluated the hydraulic conditions for the flows from the Champlin Hills residential development which we understand is to be constructed first. We then evaluated the hydraulic conditions for the addition of the flows from the Champlin Heights residential development in conjunction with the flows from the Champlin Hills development.

WASTEWATER FLOWS

EXISTING WASTEWATER FLOWS

The existing wastewater flows tributary to the Cranston sewer system consist of sewage, infiltration from groundwater, and inflow from private and public sources during wet weather events. Peak dry weather flows occur as the result of maximum daily diurnal sewage flows plus infiltration with the seasonal high groundwater table. Peak wet weather flows occur when significant storm events cause extraneous flows to enter the sewer system through drainage connections from sources such as downspouts, roof drains, area drains, sump pumps and foundation drains.

The existing peak dry and wet weather flows tributary to the sewers that will take new sewage flow from the proposed residential developments were calculated from the system wide hydraulic model developed by Stantec in 2007. Calibration of the model was achieved utilizing the flow metering program performed by Stantec for the City of Cranston in March / April 2003 as part of the Citywide I/I program. For the Sherman Avenue Pump Station tributary area, the citywide model was



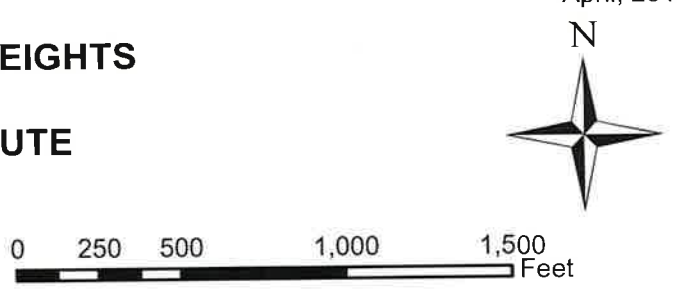
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FIGURE 1
CHAMPLIN HILLS AND CHAMPLIN HEIGHTS
SEWER MODELS
SEWER CONNECTION FLOW ROUTE



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CRANSTON, RI



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calibrated against 2 flow meters placed at strategic locations of the sewer system in addition to metering at the pump station itself.

Dry weather sanitary flows in the model were developed by applying flow factors based on land use characteristics and building areas for each sewer segment. These dry weather flows were then calibrated to include infiltration and peaking factors based on the flow metering data. Wet weather flow in the model was calibrated to wet weather events that occurred during flow metering and then applied to the 2-year (3.1 inches rainfall) design storm. **Table 1** shows the existing peak influent flows simulated by the hydraulic model at the Sherman Avenue Pump Station for dry weather and the 2-year storm event.

Table 1 Peak Existing Influent Flows to Sherman Avenue Pump Station	
Peak Dry Weather Flow	Peak Wet Weather Flow (2-Year Storm)
2.79 mgd	6.35 mgd

As seen from **Table 1**, wet weather conditions have a significant impact on peak wastewater flows. The existing capacity of the Cranston sewer system to accommodate additional wastewater flows from the proposed Champlin Hills and Champlin Heights development will be calculated from the peak wet weather flow of the 2-year storm shown in **Table 1**.

PROPOSED RESIDENTIAL DEVELOPMENTS SEWAGE FLOWS

Sewage flow calculations for the Champlin Hills and Champlin Heights Residential Developments were performed by Garofalo & Associates, Inc of Providence, RI for the developer and presented to Stantec by Veolia Water. A copy of the Garofalo transmittal letter and calculations are provided in Appendix 1 to this report. The sewage flow calculations by Garofalo were based on the Rhode Island Department of Environmental Management (RIDEM) "Flow Estimation Policy for Design of Sanitary Sewers". Average daily flows for each dwelling unit were estimated at 300 gal/unit/day for the 2-bedroom units. For each development, a peaking factor based on the sewer population and formula provided in the RIDEM Policy was applied to the average daily flow to derive the peak daily flow. A summary of the average and peak daily flows for the Champlin Hills and Champlin Heights residential developments as presented in the Garofalo report is shown in **Table 2**.

Reference: Sewer System Connection Hydraulic Analysis for the Proposed Champlin Hills and Champlin Heights Residential Developments

Table 2				
Summary of Average and Peak Sewage Flows				
Residential Development	Average Daily Flow (gpd)	Peaking Factor	Peak Daily Flow (gpd)	Peak Sewage Flow (gpm)
Champlin Hills (63 Units)	18,900	4.11	77,679	54
Champlin Heights (150 Units)	45,000	3.93	176,850	123
Champlin Hills + Champlin Heights (213 Units)	63,900		254,529	177

SEWAGE FLOWS WITH THE CHAMPLIN HILLS DEVELOPMENT

The proposed peak sewage flow rate for the Champlin Hill site of 54 gpm was added to SMH6465 on Scituate Avenue and simulated in the model during dry weather flow and the 2-year storm event. This simulation evaluated only the additional flow associate with Champlin Hills. The composite peak flow rate for each segment was compared to its respective capacity to determine if the proposed development would overload the sewer.

SEWAGE FLOWS WITH THE CHAMPLIN HEIGHTS DEVELOPMENT

The proposed peak sewage flow rate for the Champlin Heights development of 123 gpm was added to SMH6467 on Scituate Avenue together with the Champlin Hills development flow of 54 gpm to SMH6465 and the total combined flow of 177 gpm simulated in the model during dry weather flow and the 2-year storm event. The composite peak flow rate for each segment was compared to its respective capacity to determine if the proposed developments would overload the sewer.

PIPE CAPACITIES

Peak sewage flows are used for the design of new sewer lines and evaluations of carrying capacity of existing lines. Under the Cranston sewer regulations, new sewers are designed with a safety factor such that the peak flow will not cause the depth to exceed 60% of the pipe diameter. The capacity of each segment of the Cranston sewer system between the sewer connection points of the proposed developments and the Sherman Avenue Pump Station was calculated in the model based on the pipe size and slope using the Manning Equation and a friction factor, n, equal to 0.013. The peak dry weather and wet weather flows with the proposed development added were then compared to the capacity of the respective sewer segment. **Tables 3A and 4A** summarizes for Champlin Hills and Champlin Heights, respectively the pipeline segment flow rates compared to the capacities at 60% depth of flow. The last column of the 2 tables presents the post-development excess capacities for the 2-year storm event condition (pre-development excess capacity minus

Reference: Sewer System Connection Hydraulic Analysis for the Proposed Champlin Hills and Champlin Heights Residential Developments

proposed development peak flow) for each sewer segment. Where the post-development 2-year storm excess flow capacity is a negative value (i.e., the proposed peak flow exceeds the available capacity), the value is shown in bold.

As seen in **Table 3A** for the Champlin Hills development, there would be 29 pipe segments where the peak flow for the 2-year storm event would exceed the 60% depth of flow standard. However, as also seen in **Table 3A**, the existing pre-development peak flows exceed the 60% depth of flow for 25 of the 29 pipe segments. It should also be re-iterated that the 60% depth of flow standard is for construction of new sewers, not existing sewers. **Table 4A** for the Champlin Heights and Champlin Hills combined developments shows 44 pipe segments would exceed the 60% depth of flow standard for the 2-year storm event. In this case, 25 of the 44 pipe segments are already over the 60% depth for the pre-development peak flows.

Table 3B and 4B provides the comparable hydraulic calculations for each sewer segment based on full capacity of the pipe (100% depth of flow) for the Champlin Hills development and the Champlin Heights development (including Champlin Hills), respectively. As reported in **Table 3B** for Champlin Hills, there would be 8 pipe segments where the post-development 2-yr storm peak flows would exceed its full flow capacity. However, as also seen in the table, 7 of the 8 pipe segments currently exceed the pipe's full flow capacity under the pre-development 2-yr storm event condition. Similarly, as reported in **Table 4B** for the Champlin Heights development, there would be 14 pipe segments where the post-development 2-yr storm peak flows would exceed its full flow capacity. In this case, 7 of the 14 pipe segments are already over the full capacity for the pre-development peak flows.

Table 5 summarizes all the pipe segments where the post-development 2-yr storm peak flows would exceed their full flow capacities for the Champlin Hills Development and for the Champlin Heights Development excess flow capacity before and after development. The peak flow pipe capacity deficits for the Champlin Hills Development range from 0.081 mgd to 0.477 mgd for 8 pipe segments and the peak flow pipe capacity deficits for the Champlin Heights Development range from 0.033 mgd to 0.683 mgd for 14 pipe segments.

PUMP STATION CAPACITY

The Sherman Avenue Pump Station consists of three (3) Pumpex 175 HP dry pit submersible wastewater pumps. The pumps were designed to pump 3,100 gpm (4.46 mgd) at 144' TDH each. With 2 of the 3 pumps operating (with the third pump as a backup), the Sherman Ave Pump Station has a maximum capacity of 9.0 mgd. The predicted post-development peak flow at the Sherman Ave Pump Station is 6.075 mgd for Champlin Hills and 6.739 mgd for both Champlin Hills and Champlin Heights combined. The post-development sewage peak flows for the Champlin Hills and Champlin Heights added to the existing peak 2-yr storm event peak flows are well within the 9.0 mgd safe pumping capacity of the Sherman Ave Pump Station.

**TABLE 3A
PROPOSED SEWER MODIFICATION HYDRAULIC MODELING - CHAMPLIN HILLS DEVELOPMENT
CRANSTON, RI
PIPES FLOWING 60% FULL**

Label	Location	Upstream Pipeline Station (ft)	Diameter (in)	Length (ft)	Slope (ft/ft)	Upstream Manhole	Downstream Manhole	Existing Dry Weather Peak Flow (mgd)	Existing 2-Year Storm Event (3.1") Peak Flow (mgd)	60% Depth Flow Capacity (gpm)	60% Depth Flow Capacity (mgd)	Pre-Development Dry Weather Excess Flow Capacity (mgd)	Pre-Development 2-Year Storm Excess Flow Capacity (mgd)	Post-Development 2-Year Storm Event Peak Flow (mgd)	Post-Development 2-Year Storm Excess Flow Capacity (mgd)
GSP6379	Scituate Ave	0	8	279	0.059	SMH6465	SMH6466	0.115	0.115	884.95	1.274	1.159	1.159	0.247	1.027
GSP6380	Scituate Ave	279	8	169	0.082	SMH6466	SMH6467	0.117	0.117	1,043.69	1.503	1.386	1.386	0.249	1.254
GSP6381	Scituate Ave	448	8	171	0.084	SMH6467	SMH6468	0.118	0.118	1,054.53	1.519	1.400	1.400	0.250	1.268
GSP6382	Scituate Ave	618	8	218	0.067	SMH6468	SMH6469	0.118	0.118	941.97	1.356	1.238	1.238	0.250	1.106
GSP6383	Scituate Ave	836	8	276	0.036	SMH6469	SMH6470	0.118	0.118	695.13	1.001	0.883	0.883	0.250	0.751
GSP6384	Scituate Ave	1113	8	82	0.026	SMH6470	SMH6471	0.118	0.118	590.42	0.850	0.732	0.732	0.250	0.600
GSP6385	Scituate Ave	1194	8	123	0.057	SMH6471	SMH3319	0.118	0.118	868.87	1.251	1.133	1.133	0.250	1.001
GSP3191	Cross Country	1317	8	88	0.023	SMH3319	SMH3318	0.118	0.118	553.61	0.797	0.679	0.679	0.250	0.547
GSP3190	Cross Country	1405	8	87	0.017	SMH3318	SMH3317	0.119	0.119	471.48	0.679	0.560	0.560	0.250	0.429
GSP3189	Cross Country	1491	8	182	0.007	SMH3317	SMH3316	0.119	0.119	302.38	0.435	0.316	0.316	0.251	0.185
GSP3188	Cross Country	1673	8	269	0.007	SMH3316	SMH3315	0.125	0.125	295.56	0.426	0.300	0.300	0.256	0.169
GSP3187	Cross Country	1942	8	66	0.040	SMH3315	SMH3297	0.131	0.131	729.83	1.051	0.920	0.920	0.262	0.789
GSP3172	Midland St	2008	8	115	0.010	SMH3297	SMH3296	0.132	0.132	372.85	0.537	0.405	0.405	0.263	0.274
GSP3171	Midland St	2122	8	73	0.011	SMH3296	SMH3295	0.133	0.133	389.32	0.561	0.428	0.428	0.264	0.297
GSP3170	Midland St	2195	8	67	0.012	SMH3295	SMH3294	0.134	0.134	391.78	0.564	0.430	0.430	0.264	0.300
GSP3169	Midland St	2261	8	224	0.011	SMH3294	SMH3298	0.136	0.136	376.45	0.542	0.406	0.406	0.266	0.276
GSP3168	Midland St	2485	8	255	0.013	SMH3298	SMH3292	0.143	0.143	413.08	0.595	0.452	0.452	0.273	0.322
GSP3167	Midland St	2741	8	231	0.019	SMH3292	SMH3394	0.150	0.958	504.71	0.727	0.577	-0.231	1.050	-0.323
GSP3267	Phenix Ave	2972	10	147	0.004	SMH3394	SMH3396	0.153	0.957	425.42	0.613	0.459	-0.344	1.049	-0.436
GP20010	Phenix Ave	3119	10	22	0.007	SMH3396	SMH3397	0.154	0.957	569.90	0.821	0.667	-0.136	1.048	-0.227
GSP3270	Phenix Ave	3141	10	194	0.003	SMH3397	SMH3398	0.235	1.015	382.01	0.550	0.315	-0.465	1.102	-0.552
GSP3271	Phenix Ave	3335	10	113	0.002	SMH3398	SMH3399	0.237	1.016	328.85	0.474	0.237	-0.542	1.103	-0.629
GSP6474	Cross Country	3448	10	262	0.004	SMH3399	SMH6541	0.237	1.016	401.67	0.578	0.341	-0.437	1.103	-0.525
GSP6475	Cross Country	3710	10	259	0.002	SMH6541	SMH6542	0.238	1.016	328.72	0.473	0.236	-0.543	1.104	-0.630
GSP6476	Cross Country	3969	10	256	0.011	SMH6542	SMH6543	0.238	1.016	690.91	0.995	0.757	-0.021	1.104	-0.109
GSP6477	Cross Country	4225	10	300	0.025	SMH6543	SMH6544	0.238	1.016	1,051.50	1.514	1.276	0.498	1.104	0.410
GSP6478	Cross Country	4524	10	169	0.025	SMH6544	SMH6545	0.239	1.016	1,053.49	1.517	1.278	0.501	1.104	0.413
GSP6479	Cross Country	4693	12	310	0.005	SMH6545	SMH6546	0.254	1.026	766.93	1.104	0.851	0.078	1.114	-0.010
GSP6480	Cross Country	5003	12	192	0.005	SMH6546	SMH6547	0.254	1.026	764.56	1.101	0.847	0.075	1.114	-0.013
GSP6481	Cross Country	5195	12	188	0.005	SMH6547	SMH6548	0.254	1.025	779.35	1.122	0.868	0.097	1.113	0.009
GSP6482	Cross Country	5383	12	217	0.005	SMH6548	SMH3320	0.255	1.025	791.63	1.140	0.885	0.115	1.113	0.027
GSP3192	Cross Country	5600	14	272	0.003	SMH3320	SMH3321	0.355	1.096	827.45	1.192	0.837	0.095	1.185	0.006
GSP3193	Cross Country	5872	14	258	0.003	SMH3321	SMH3322	0.358	1.098	850.07	1.224	0.866	0.126	1.187	0.037
GSP3194	Cross Country	6130	14	245	0.004	SMH3322	SMH3323	0.361	1.099	966.03	1.391	1.030	0.292	1.189	0.202
GSP3195	Cross Country	6375	14	242	0.001	SMH3323	SMH3324	0.362	1.099	561.42	0.808	0.447	-0.291	1.189	-0.380
GSP3196	Cross Country	6617	14	241	0.003	SMH3324	SMH3325	0.365	1.101	860.05	1.238	0.873	0.137	1.191	0.048
GSP3206	Curtis St	6858	14	231	0.003	SMH3325	SMH3336	0.378	1.110	905.07	1.303	0.925	0.193	1.200	0.104
GSP3207	Curtis St	7089	14	182	0.003	SMH3336	SMH3337	0.420	1.139	841.97	1.212	0.792	0.073	1.229	-0.016
GSP3208	Curtis St	7270	14	200	0.002	SMH3337	SMH3332	0.422	1.862	688.01	0.991	0.569	-0.871	1.952	-0.961

**TABLE 3A
PROPOSED SEWER MODIFICATION HYDRAULIC MODELING - CHAMPLIN HILLS DEVELOPMENT
CRANSTON, RI
PIPES FLOWING 60% FULL**

Label	Location	Upstream Pipeline Station (ft)	Diameter (in)	Length (ft)	Slope (ft/ft)	Upstream Manhole	Downstream Manhole	Existing Dry Weather Peak Flow (mgd)	Existing 2-Year Storm Event (3.1") Peak Flow (mgd)	60% Depth Flow Capacity (gpm)	60% Depth Flow Capacity (mgd)	Pre-Development Dry Weather Excess Flow Capacity (mgd)	Pre-Development 2-Year Storm Excess Flow Capacity (mgd)	Post-Development 2-Year Storm Event Peak Flow (mgd)	Post-Development 2-Year Storm Excess Flow Capacity (mgd)
GSP3202	Wine St	7470	14	201	0.004	SMH3332	SMH3331	0.438	1.872	995.68	1.434	0.996	-0.438	1.962	-0.528
GSP3201	Wine St	7671	14	227	0.005	SMH3331	SMH3330	0.441	1.874	1,177.41	1.695	1.255	-0.178	1.964	-0.268
GSP3200	Wine St	7899	14	221	0.009	SMH3330	SMH3329	0.443	1.874	1,495.93	2.154	1.712	0.280	1.964	0.190
GSP3199	Wine St	8119	14	232	0.014	SMH3329	SMH3328	0.445	1.875	1,901.48	2.738	2.294	0.863	1.965	0.773
GSP3198	Wine St	8352	14	230	0.013	SMH3328	SMH3327	0.448	1.877	1,879.64	2.707	2.259	0.830	1.967	0.740
GSP7208	Cross Country	8582	14	124	0.006	SMH3327	SMH3326	0.486	1.903	1,275.40	1.837	1.351	-0.067	1.994	-0.157
GSP7207	Cross Country	8706	14	333	0.003	SMH3326	SMH3356	0.486	1.903	892.03	1.285	0.798	-0.618	1.993	-0.708
GSP3197	Cross Country	9040	14	334	0.003	SMH3356	SMH1095	0.512	1.920	946.85	1.363	0.851	-0.557	2.010	-0.647
GSP10235	Cross Country	9374	15	150	0.004	SMH1095	SMH7035	0.522	1.926	1,156.63	1.666	1.143	-0.260	2.016	-0.351
GSP10234	Cross Country	9524	15	288	0.003	SMH7035	SMH7036	0.522	1.925	1,052.46	1.516	0.993	-0.409	2.015	-0.499
GSP10233	Cross Country	9812	15	167	0.005	SMH7036	SMH7037	0.522	1.923	1,390.43	2.002	1.480	0.079	2.013	-0.011
GSP10232	Cross Country	9978	15	257	0.003	SMH7037	SMH5431	0.522	1.922	1,107.12	1.594	1.072	-0.328	2.012	-0.418
GSP5329	Cross Country	10235	18	192	0.004	SMH5431	SMH5432	0.799	2.774	2,096.60	3.019	2.221	0.245	2.864	0.155
GSP5330	Cross Country	10427	18	247	0.004	SMH5432	SMH5433	0.799	3.306	1,902.38	2.739	1.940	-0.566	3.396	-0.657
GSP5331	Cross Country	10674	18	232	0.003	SMH5433	SMH5434	0.802	3.306	1,716.22	2.471	1.669	-0.835	3.396	-0.925
GSP5332	Cross Country	10905	18	202	0.003	SMH5434	SMH5435	0.808	3.308	1,621.97	2.336	1.528	-0.972	3.398	-1.063
GSP5333	Cross Country	11107	18	212	0.002	SMH5435	SMH5436	0.824	3.317	1,538.17	2.215	1.391	-1.102	3.408	-1.193
GSP5334	Cross Country	11319	18	251	0.003	SMH5436	SMH5437	0.824	3.316	1,766.33	2.544	1.719	-0.772	3.407	-0.863
GSP5335	Cross Country	11570	18	261	0.003	SMH5437	SMH5438	0.825	3.314	1,763.44	2.539	1.714	-0.774	3.405	-0.866
GSP5336	Cross Country	11832	18	261	0.004	SMH5438	SMH5428	0.826	3.312	1,912.69	2.754	1.928	-0.558	3.403	-0.649
GSP5323	Sherman Ave	12092	18	58	0.023	SMH5428	SMH5427	1.267	5.950	4,768.25	6.866	5.599	0.916	6.041	0.825
CO-29	Sherman Ave	12150	30	24	0.004	SMH5427	WW-17	1.268	5.982	7,821.93	11.264	9.996	5.282	6.075	5.189
Deficient Capacity Segments													25		29

Note: Bolded values indicate the sewer segment flow capacity deficit to handle the peak flow including the proposed development

**TABLE 3B
PROPOSED SEWER MODIFICATION HYDRAULIC MODELING - CHAMPLIN HILLS DEVELOPMENT
CRANSTON, RI
PIPES FLOWING 100% FULL**

Label	Location	Upstream Pipeline Station (ft)	Diameter (in)	Length (ft)	Slope (ft/ft)	Upstream Manhole	Downstream Manhole	Existing Dry Weather Peak Flow (mgd)	Existing 2-Year Storm Event (3.1") Peak Flow (mgd)	Full Capacity (gpm)	Full Capacity (mgd)	Pre-Development Dry Weather Excess Flow Capacity (mgd)	Pre-Development 2-Year Storm Excess Flow Capacity (mgd)	Post-Development 2-Year Storm Event Peak Flow (mgd)	Post-Development 2-Year Storm Excess Flow Capacity (mgd)
GSP6379	Scituate Ave	0	8	279	0.059	SMH6465	SMH6466	0.115	0.115	1317.23	1.897	1.782	1.782	0.247	1.649
GSP6380	Scituate Ave	279	8	169	0.082	SMH6466	SMH6467	0.117	0.117	1553.51	2.237	2.120	2.120	0.249	1.988
GSP6381	Scituate Ave	448	8	171	0.084	SMH6467	SMH6468	0.118	0.118	1569.64	2.260	2.142	2.142	0.250	2.010
GSP6382	Scituate Ave	618	8	218	0.067	SMH6468	SMH6469	0.118	0.118	1402.07	2.019	1.901	1.901	0.250	1.769
GSP6383	Scituate Ave	836	8	276	0.036	SMH6469	SMH6470	0.118	0.118	1034.70	1.490	1.372	1.372	0.250	1.240
GSP6384	Scituate Ave	1113	8	82	0.026	SMH6470	SMH6471	0.118	0.118	878.56	1.265	1.147	1.147	0.250	1.015
GSP6385	Scituate Ave	1194	8	123	0.057	SMH6471	SMH3319	0.118	0.118	1293.04	1.862	1.744	1.744	0.250	1.612
GSP3191	Cross Country	1317	8	88	0.023	SMH3319	SMH3318	0.118	0.118	823.86	1.186	1.068	1.068	0.250	0.936
GSP3190	Cross Country	1405	8	87	0.017	SMH3318	SMH3317	0.119	0.119	701.75	1.011	0.892	0.892	0.250	0.760
GSP3189	Cross Country	1491	8	182	0.007	SMH3317	SMH3316	0.119	0.119	450.03	0.648	0.529	0.529	0.251	0.397
GSP3188	Cross Country	1673	8	269	0.007	SMH3316	SMH3315	0.125	0.125	439.94	0.634	0.508	0.508	0.256	0.377
GSP3187	Cross Country	1942	8	66	0.040	SMH3315	SMH3297	0.131	0.131	1086.41	1.564	1.433	1.433	0.262	1.302
GSP3172	Midland St	2008	8	115	0.010	SMH3297	SMH3296	0.132	0.132	555.06	0.799	0.667	0.667	0.263	0.536
GSP3171	Midland St	2122	8	73	0.011	SMH3296	SMH3295	0.133	0.133	579.40	0.834	0.701	0.701	0.264	0.571
GSP3170	Midland St	2195	8	67	0.012	SMH3295	SMH3294	0.134	0.134	583.21	0.840	0.706	0.706	0.264	0.575
GSP3169	Midland St	2261	8	224	0.011	SMH3294	SMH3298	0.136	0.136	560.38	0.807	0.671	0.671	0.266	0.541
GSP3168	Midland St	2485	8	255	0.013	SMH3298	SMH3292	0.143	0.143	614.83	0.885	0.742	0.742	0.273	0.612
GSP3167	Midland St	2741	8	231	0.019	SMH3292	SMH3394	0.150	0.958	751.20	1.082	0.932	0.124	1.050	0.032
GSP3267	Phenix Ave	2972	10	147	0.004	SMH3394	SMH3396	0.153	0.957	633.18	0.912	0.759	-0.045	1.049	-0.137
GP20010	Phenix Ave	3119	10	22	0.007	SMH3396	SMH3397	0.154	0.957	847.51	1.220	1.066	0.263	1.048	0.172
GSP3270	Phenix Ave	3141	10	194	0.003	SMH3397	SMH3398	0.235	1.015	568.54	0.819	0.584	-0.196	1.102	-0.283
GSP3271	Phenix Ave	3335	10	113	0.002	SMH3398	SMH3399	0.237	1.016	489.42	0.705	0.468	-0.311	1.103	-0.398
GSP6474	Cross Country	3448	10	262	0.004	SMH3399	SMH6541	0.237	1.016	597.91	0.861	0.624	-0.155	1.103	-0.242
GSP6475	Cross Country	3710	10	259	0.002	SMH6541	SMH6542	0.238	1.016	489.28	0.705	0.467	-0.312	1.104	-0.399
GSP6476	Cross Country	3969	10	256	0.011	SMH6542	SMH6543	0.238	1.016	1028.31	1.481	1.243	0.464	1.104	0.377
GSP6477	Cross Country	4225	10	300	0.025	SMH6543	SMH6544	0.238	1.016	1565.16	2.254	2.015	1.237	1.104	1.150
GSP6478	Cross Country	4524	10	169	0.025	SMH6544	SMH6545	0.239	1.016	1568.08	2.258	2.019	1.242	1.104	1.154
GSP6479	Cross Country	4693	12	310	0.005	SMH6545	SMH6546	0.254	1.026	1141.54	1.644	1.390	0.618	1.114	0.530
GSP6480	Cross Country	5003	12	192	0.005	SMH6546	SMH6547	0.254	1.026	1138.13	1.639	1.385	0.613	1.114	0.525
GSP6481	Cross Country	5195	12	188	0.005	SMH6547	SMH6548	0.254	1.025	1160.13	1.671	1.416	0.646	1.113	0.557
GSP6482	Cross Country	5383	12	217	0.005	SMH6548	SMH3320	0.255	1.025	1178.26	1.697	1.442	0.672	1.113	0.584
GSP3192	Cross Country	5600	14	272	0.003	SMH3320	SMH3321	0.355	1.096	1231.66	1.774	1.419	0.677	1.185	0.588
GSP3193	Cross Country	5872	14	258	0.003	SMH3321	SMH3322	0.358	1.098	1265.31	1.822	1.464	0.724	1.187	0.635
GSP3194	Cross Country	6130	14	245	0.004	SMH3322	SMH3323	0.361	1.099	1437.90	2.071	1.709	0.971	1.189	0.882
GSP3195	Cross Country	6375	14	242	0.001	SMH3323	SMH3324	0.362	1.099	835.65	1.203	0.842	0.104	1.189	0.015
GSP3196	Cross Country	6617	14	241	0.003	SMH3324	SMH3325	0.365	1.101	1280.15	1.843	1.478	0.742	1.191	0.653
GSP3206	Curtis St	6858	14	231	0.003	SMH3325	SMH3336	0.378	1.110	1347.13	1.940	1.562	0.830	1.200	0.740
GSP3207	Curtis St	7089	14	182	0.003	SMH3336	SMH3337	0.420	1.139	1253.20	1.805	1.384	0.666	1.229	0.576
GSP3208	Curtis St	7270	14	200	0.002	SMH3337	SMH3332	0.422	1.862	1023.97	1.475	1.053	-0.387	1.952	-0.477
GSP3202	Wine St	7470	14	201	0.004	SMH3332	SMH3331	0.438	1.872	1482.02	2.134	1.696	0.262	1.962	0.172

**TABLE 3B
PROPOSED SEWER MODIFICATION HYDRAULIC MODELING - CHAMPLIN HILLS DEVELOPMENT
CRANSTON, RI
PIPES FLOWING 100% FULL**

Label	Location	Upstream Pipeline Station (ft)	Diameter (in)	Length (ft)	Slope (ft/ft)	Upstream Manhole	Downstream Manhole	Existing Dry Weather Peak Flow (mgd)	Existing 2-Year Storm Event (3.1") Peak Flow (mgd)	Full Capacity (gpm)	Full Capacity (mgd)	Pre-Development Dry Weather Excess Flow Capacity (mgd)	Pre-Development 2-Year Storm Excess Flow Capacity (mgd)	Post-Development 2-Year Storm Event Peak Flow (mgd)	Post-Development 2-Year Storm Excess Flow Capacity (mgd)
GSP3201	Wine St	7671	14	227	0.005	SMH3331	SMH3330	0.441	1.874	1752.71	2.524	2.083	0.650	1.964	0.560
GSP3200	Wine St	7899	14	221	0.009	SMH3330	SMH3329	0.443	1.874	2226.57	3.206	2.764	1.332	1.964	1.242
GSP3199	Wine St	8119	14	232	0.014	SMH3329	SMH3328	0.445	1.875	2830.20	4.075	3.631	2.200	1.965	2.110
GSP3198	Wine St	8352	14	230	0.013	SMH3328	SMH3327	0.448	1.877	2797.56	4.028	3.581	2.152	1.967	2.061
GSP7208	Cross Country	8582	14	124	0.006	SMH3327	SMH3326	0.486	1.903	1898.02	2.733	2.248	0.830	1.994	0.739
GSP7207	Cross Country	8706	14	333	0.003	SMH3326	SMH3356	0.486	1.903	1327.78	1.912	1.426	0.009	1.993	-0.081
GSP3197	Cross Country	9040	14	334	0.003	SMH3356	SMH1095	0.512	1.920	1409.44	2.030	1.517	0.110	2.010	0.019
GSP10235	Cross Country	9374	15	150	0.004	SMH1095	SMH7035	0.522	1.926	1734.10	2.497	1.975	0.571	2.016	0.481
GSP10234	Cross Country	9524	15	288	0.003	SMH7035	SMH7036	0.522	1.925	1758.66	2.532	2.010	0.608	2.015	0.518
GSP10233	Cross Country	9812	15	167	0.005	SMH7036	SMH7037	0.522	1.923	1566.57	2.256	1.734	0.333	2.013	0.242
GSP10232	Cross Country	9978	15	257	0.003	SMH7037	SMH5431	0.522	1.922	1721.34	2.479	1.957	0.557	2.012	0.467
GSP5329	Cross Country	10235	18	192	0.004	SMH5431	SMH5432	0.799	2.774	3120.73	4.494	3.695	1.720	2.864	1.630
GSP5330	Cross Country	10427	18	247	0.004	SMH5432	SMH5433	0.799	3.306	2831.64	4.078	3.278	0.772	3.396	0.681
GSP5331	Cross Country	10674	18	232	0.003	SMH5433	SMH5434	0.802	3.306	2554.54	3.679	2.876	0.373	3.396	0.282
GSP5332	Cross Country	10905	18	202	0.003	SMH5434	SMH5435	0.808	3.308	2414.31	3.477	2.669	0.169	3.398	0.078
GSP5333	Cross Country	11107	18	212	0.002	SMH5435	SMH5436	0.824	3.317	2289.52	3.297	2.473	-0.020	3.408	-0.111
GSP5334	Cross Country	11319	18	251	0.003	SMH5436	SMH5437	0.824	3.316	2629.13	3.786	2.962	0.470	3.407	0.379
GSP5335	Cross Country	11570	18	261	0.003	SMH5437	SMH5438	0.825	3.314	2624.83	3.780	2.955	0.466	3.405	0.375
GSP5336	Cross Country	11832	18	261	0.004	SMH5438	SMH5428	0.826	3.312	2846.86	4.099	3.274	0.787	3.403	0.696
GSP5323	Sherman Ave	12092	18	58	0.023	SMH5428	SMH5427	1.267	5.950	7096.98	10.220	8.952	4.269	6.041	4.179
CO-29	Sherman Ave	12150	30	24	0.004	SMH5427	WW-17	1.268	5.982	11397.59	16.413	15.145	10.431	6.075	10.338
												Deficient Capacity Segments	7		8

Note: Bolded values indicate the sewer segment flow capacity deficit to handle the peak flow including the proposed development

**TABLE 4A
PROPOSED SEWER MODIFICATION HYDRAULIC MODELING - CHAMPLIN HEIGHTS DEVELOPMENT
CRANSTON, RI
PIPES FLOWING 60% FULL**

Label	Location	Upstream Pipeline Station (ft)	Diameter (in)	Length (ft)	Slope (ft/ft)	Upstream Manhole	Downstream Manhole	Existing Dry Weather Peak Flow (mgd)	Existing 2-Year Storm Event (3.1") Peak Flow (mgd)	60% Depth Flow Capacity (gpm)	60% Depth Flow Capacity (mgd)	Pre-Development Dry Weather Excess Flow Capacity (mgd)	Pre-Development 2-Year Storm Excess Flow Capacity (mgd)	Post-Development 2-Year Storm Event Peak Flow (mgd)	Post-Development 2-Year Storm Excess Flow Capacity (mgd)
GSP6379	Scituate Ave	0	8	279	0.059	SMH6465	SMH6466	0.115	0.115	884.95	1.274	1.159	1.159	0.247	1.027
GSP6380	Scituate Ave	279	8	169	0.082	SMH6466	SMH6467	0.117	0.117	1,043.69	1.503	1.386	1.386	0.249	1.254
GSP6381	Scituate Ave	448	8	171	0.084	SMH6467	SMH6468	0.118	0.118	1,054.53	1.519	1.400	1.400	0.557	0.962
GSP6382	Scituate Ave	618	8	218	0.067	SMH6468	SMH6469	0.118	0.118	941.97	1.356	1.238	1.238	0.557	0.800
GSP6383	Scituate Ave	836	8	276	0.036	SMH6469	SMH6470	0.118	0.118	695.13	1.001	0.883	0.883	0.556	0.445
GSP6384	Scituate Ave	1113	8	82	0.026	SMH6470	SMH6471	0.118	0.118	590.42	0.850	0.732	0.732	0.556	0.294
GSP6385	Scituate Ave	1194	8	123	0.057	SMH6471	SMH3319	0.118	0.118	868.87	1.251	1.133	1.133	0.556	0.695
GSP3191	Cross Country	1317	8	88	0.023	SMH3319	SMH3318	0.118	0.118	553.61	0.797	0.679	0.679	0.556	0.241
GSP3190	Cross Country	1405	8	87	0.017	SMH3318	SMH3317	0.119	0.119	471.48	0.679	0.560	0.560	0.556	0.123
GSP3189	Cross Country	1491	8	182	0.007	SMH3317	SMH3316	0.119	0.119	302.38	0.435	0.316	0.316	0.556	-0.121
GSP3188	Cross Country	1673	8	269	0.007	SMH3316	SMH3315	0.125	0.125	295.56	0.426	0.300	0.300	0.562	-0.136
GSP3187	Cross Country	1942	8	66	0.040	SMH3315	SMH3297	0.131	0.131	729.83	1.051	0.920	0.920	0.567	0.484
GSP3172	Midland St	2008	8	115	0.010	SMH3297	SMH3296	0.132	0.132	372.85	0.537	0.405	0.405	0.568	-0.031
GSP3171	Midland St	2122	8	73	0.011	SMH3296	SMH3295	0.133	0.133	389.32	0.561	0.428	0.428	0.569	-0.008
GSP3170	Midland St	2195	8	67	0.012	SMH3295	SMH3294	0.134	0.134	391.78	0.564	0.430	0.430	0.569	-0.005
GSP3169	Midland St	2261	8	224	0.011	SMH3294	SMH3298	0.136	0.136	376.45	0.542	0.406	0.406	0.571	-0.029
GSP3168	Midland St	2485	8	255	0.013	SMH3298	SMH3292	0.143	0.143	413.08	0.595	0.452	0.452	0.577	0.018
GSP3167	Midland St	2741	8	231	0.019	SMH3292	SMH3394	0.150	0.958	504.71	0.727	0.577	-0.231	1.256	-0.529
GSP3267	Phenix Ave	2972	10	147	0.004	SMH3394	SMH3396	0.153	0.957	425.42	0.613	0.459	-0.344	1.254	-0.642
GP20010	Phenix Ave	3119	10	22	0.007	SMH3396	SMH3397	0.154	0.957	569.90	0.821	0.667	-0.136	1.254	-0.434
GSP3270	Phenix Ave	3141	10	194	0.003	SMH3397	SMH3398	0.235	1.015	382.01	0.550	0.315	-0.465	1.311	-0.761
GSP3271	Phenix Ave	3335	10	113	0.002	SMH3398	SMH3399	0.237	1.016	328.85	0.474	0.237	-0.542	1.312	-0.839
GSP6474	Cross Country	3448	10	262	0.004	SMH3399	SMH6541	0.237	1.016	401.67	0.578	0.341	-0.437	1.312	-0.734
GSP6475	Cross Country	3710	10	259	0.002	SMH6541	SMH6542	0.238	1.016	328.72	0.473	0.236	-0.543	1.312	-0.839
GSP6476	Cross Country	3969	10	256	0.011	SMH6542	SMH6543	0.238	1.016	690.91	0.995	0.757	-0.021	1.313	-0.318
GSP6477	Cross Country	4225	10	300	0.025	SMH6543	SMH6544	0.238	1.016	1,051.50	1.514	1.276	0.498	1.312	0.202
GSP6478	Cross Country	4524	10	169	0.025	SMH6544	SMH6545	0.239	1.016	1,053.49	1.517	1.278	0.501	1.312	0.205
GSP6479	Cross Country	4693	12	310	0.005	SMH6545	SMH6546	0.254	1.026	766.93	1.104	0.851	0.078	1.322	-0.218
GSP6480	Cross Country	5003	12	192	0.005	SMH6546	SMH6547	0.254	1.026	764.56	1.101	0.847	0.075	1.322	-0.221
GSP6481	Cross Country	5195	12	188	0.005	SMH6547	SMH6548	0.254	1.025	779.35	1.122	0.868	0.097	1.322	-0.200
GSP6482	Cross Country	5383	12	217	0.005	SMH6548	SMH3320	0.255	1.025	791.63	1.140	0.885	0.115	1.322	-0.182
GSP3192	Cross Country	5600	14	272	0.003	SMH3320	SMH3321	0.355	1.096	827.45	1.192	0.837	0.095	1.394	-0.202
GSP3193	Cross Country	5872	14	258	0.003	SMH3321	SMH3322	0.358	1.098	850.07	1.224	0.866	0.126	1.395	-0.171
GSP3194	Cross Country	6130	14	245	0.004	SMH3322	SMH3323	0.361	1.099	966.03	1.391	1.030	0.292	1.397	-0.006
GSP3195	Cross Country	6375	14	242	0.001	SMH3323	SMH3324	0.362	1.099	561.42	0.808	0.447	-0.291	1.397	-0.588
GSP3196	Cross Country	6617	14	241	0.003	SMH3324	SMH3325	0.365	1.101	860.05	1.238	0.873	0.137	1.399	-0.161
GSP3206	Curtis St	6858	14	231	0.003	SMH3325	SMH3336	0.378	1.110	905.07	1.303	0.925	0.193	1.407	-0.104
GSP3207	Curtis St	7089	14	182	0.003	SMH3336	SMH3337	0.420	1.139	841.97	1.212	0.792	0.073	1.433	-0.221
GSP3208	Curtis St	7270	14	200	0.002	SMH3337	SMH3332	0.422	1.862	688.01	0.991	0.569	-0.871	2.157	-1.167

**TABLE 4A
PROPOSED SEWER MODIFICATION HYDRAULIC MODELING - CHAMPLIN HEIGHTS DEVELOPMENT
CRANSTON, RI
PIPES FLOWING 60% FULL**

Label	Location	Upstream Pipeline Station (ft)	Diameter (in)	Length (ft)	Slope (ft/ft)	Upstream Manhole	Downstream Manhole	Existing Dry Weather Peak Flow (mgd)	Existing 2-Year Storm Event (3.1") Peak Flow (mgd)	60% Depth Flow Capacity (gpm)	60% Depth Flow Capacity (mgd)	Pre-Development Dry Weather Excess Flow Capacity (mgd)	Pre-Development 2-Year Storm Excess Flow Capacity (mgd)	Post-Development 2-Year Storm Event Peak Flow (mgd)	Post-Development 2-Year Storm Excess Flow Capacity (mgd)
GSP3202	Wine St	7470	14	201	0.004	SMH3332	SMH3331	0.438	1.872	995.68	1.434	0.996	-0.438	2.167	-0.734
GSP3201	Wine St	7671	14	227	0.005	SMH3331	SMH3330	0.441	1.874	1,177.41	1.695	1.255	-0.178	2.169	-0.473
GSP3200	Wine St	7899	14	221	0.009	SMH3330	SMH3329	0.443	1.874	1,495.93	2.154	1.712	0.280	2.169	-0.015
GSP3199	Wine St	8119	14	232	0.014	SMH3329	SMH3328	0.445	1.875	1,901.48	2.738	2.294	0.863	2.170	0.569
GSP3198	Wine St	8352	14	230	0.013	SMH3328	SMH3327	0.448	1.877	1,879.64	2.707	2.259	0.830	2.171	0.536
GSP7208	Cross Country	8582	14	124	0.006	SMH3327	SMH3326	0.486	1.903	1,275.40	1.837	1.351	-0.067	2.195	-0.359
GSP7207	Cross Country	8706	14	333	0.003	SMH3326	SMH3356	0.486	1.903	892.03	1.285	0.798	-0.618	2.191	-0.907
GSP3197	Cross Country	9040	14	334	0.003	SMH3356	SMH1095	0.512	1.920	946.85	1.363	0.851	-0.557	2.207	-0.844
GSP10235	Cross Country	9374	15	150	0.004	SMH1095	SMH7035	0.522	1.926	1,156.63	1.666	1.143	-0.260	2.213	-0.547
GSP10234	Cross Country	9524	15	288	0.003	SMH7035	SMH7036	0.522	1.925	1,052.46	1.516	0.993	-0.409	2.211	-0.695
GSP10233	Cross Country	9812	15	167	0.005	SMH7036	SMH7037	0.522	1.923	1,390.43	2.002	1.480	0.079	2.209	-0.207
GSP10232	Cross Country	9978	15	257	0.003	SMH7037	SMH5431	0.522	1.922	1,107.12	1.594	1.072	-0.328	2.207	-0.613
GSP5329	Cross Country	10235	18	192	0.004	SMH5431	SMH5432	0.799	2.774	2,096.60	3.019	2.221	0.245	3.060	-0.041
GSP5330	Cross Country	10427	18	247	0.004	SMH5432	SMH5433	0.799	3.306	1,902.38	2.739	1.940	-0.566	3.592	-0.853
GSP5331	Cross Country	10674	18	232	0.003	SMH5433	SMH5434	0.802	3.306	1,716.22	2.471	1.669	-0.835	3.591	-1.120
GSP5332	Cross Country	10905	18	202	0.003	SMH5434	SMH5435	0.808	3.308	1,621.97	2.336	1.528	-0.972	3.592	-1.256
GSP5333	Cross Country	11107	18	212	0.002	SMH5435	SMH5436	0.824	3.317	1,538.17	2.215	1.391	-1.102	3.600	-1.385
GSP5334	Cross Country	11319	18	251	0.003	SMH5436	SMH5437	0.824	3.316	1,766.33	2.544	1.719	-0.772	3.598	-1.054
GSP5335	Cross Country	11570	18	261	0.003	SMH5437	SMH5438	0.825	3.314	1,763.44	2.539	1.714	-0.774	3.595	-1.056
GSP5336	Cross Country	11832	18	261	0.004	SMH5438	SMH5428	0.826	3.312	1,912.69	2.754	1.928	-0.558	3.593	-0.839
GSP5323	Sherman Ave	12092	18	58	0.023	SMH5428	SMH5427	1.267	5.950	4,768.25	6.866	5.599	0.916	6.712	0.155
CO-29	Sherman Ave	12150	30	24	0.004	SMH5427	WW-17	1.268	5.982	7,821.93	11.264	9.996	5.282	6.739	4.525
												Deficient Capacity Segments	25		44

Note: Bolded values indicate the sewer segment flow capacity deficit to handle the peak flow including the proposed development

TABLE 4B
PROPOSED SEWER MODIFICATION HYDRAULIC MODELING - CHAMPLIN HEIGHTS DEVELOPMENT
CRANSTON, RI
PIPES FLOWING 100% FULL

Label	Location	Upstream Pipeline Station (ft)	Diameter (in)	Length (ft)	Slope (ft/ft)	Upstream Manhole	Downstream Manhole	Existing Dry Weather Peak Flow (mgd)	Existing 2-Year Storm Event (3.1") Peak Flow (mgd)	Full Capacity (gpm)	Full Capacity (mgd)	Pre-Development Dry Weather Excess Flow Capacity (mgd)	Pre-Development 2-Year Storm Excess Flow Capacity (mgd)	Post-Development 2-Year Storm Event Peak Flow (mgd)	Post-Development 2-Year Storm Excess Flow Capacity (mgd)
GSP6379	Scituate Ave	0	8	279	0.059	SMH6465	SMH6466	0.115	0.115	1317.23	1.897	1.782	1.782	0.247	1.650
GSP6380	Scituate Ave	279	8	169	0.082	SMH6466	SMH6467	0.117	0.117	1553.51	2.237	2.120	2.120	0.249	1.988
GSP6381	Scituate Ave	448	8	171	0.084	SMH6467	SMH6468	0.118	0.118	1569.64	2.260	2.142	2.142	0.557	1.704
GSP6382	Scituate Ave	618	8	218	0.067	SMH6468	SMH6469	0.118	0.118	1402.07	2.019	1.901	1.901	0.557	1.462
GSP6383	Scituate Ave	836	8	276	0.036	SMH6469	SMH6470	0.118	0.118	1034.70	1.490	1.372	1.372	0.556	0.934
GSP6384	Scituate Ave	1113	8	82	0.026	SMH6470	SMH6471	0.118	0.118	878.56	1.265	1.147	1.147	0.556	0.709
GSP6385	Scituate Ave	1194	8	123	0.057	SMH6471	SMH3319	0.118	0.118	1293.04	1.862	1.744	1.744	0.556	1.306
GSP3191	Cross Country	1317	8	88	0.023	SMH3319	SMH3318	0.118	0.118	823.86	1.186	1.068	1.068	0.556	0.630
GSP3190	Cross Country	1405	8	87	0.017	SMH3318	SMH3317	0.119	0.119	701.75	1.011	0.892	0.892	0.556	0.454
GSP3189	Cross Country	1491	8	182	0.007	SMH3317	SMH3316	0.119	0.119	450.03	0.648	0.529	0.529	0.556	0.092
GSP3188	Cross Country	1673	8	269	0.007	SMH3316	SMH3315	0.125	0.125	439.94	0.634	0.508	0.508	0.562	0.072
GSP3187	Cross Country	1942	8	66	0.040	SMH3315	SMH3297	0.131	0.131	1086.41	1.564	1.433	1.433	0.567	0.997
GSP3172	Midland St	2008	8	115	0.010	SMH3297	SMH3296	0.132	0.132	555.06	0.799	0.667	0.667	0.568	0.231
GSP3171	Midland St	2122	8	73	0.011	SMH3296	SMH3295	0.133	0.133	579.40	0.834	0.701	0.701	0.569	0.266
GSP3170	Midland St	2195	8	67	0.012	SMH3295	SMH3294	0.134	0.134	583.21	0.840	0.706	0.706	0.569	0.271
GSP3169	Midland St	2261	8	224	0.011	SMH3294	SMH3298	0.136	0.136	560.38	0.807	0.671	0.671	0.571	0.236
GSP3168	Midland St	2485	8	255	0.013	SMH3298	SMH3292	0.143	0.143	614.83	0.885	0.742	0.742	0.577	0.308
GSP3167	Midland St	2741	8	231	0.019	SMH3292	SMH3394	0.150	0.958	751.20	1.082	0.932	0.124	1.256	-0.174
GSP3267	Phenix Ave	2972	10	147	0.004	SMH3394	SMH3396	0.153	0.957	633.18	0.912	0.759	-0.045	1.254	-0.342
GP20010	Phenix Ave	3119	10	22	0.007	SMH3396	SMH3397	0.154	0.957	847.51	1.220	1.066	0.263	1.254	-0.034
GSP3270	Phenix Ave	3141	10	194	0.003	SMH3397	SMH3398	0.235	1.015	568.54	0.819	0.584	-0.196	1.311	-0.493
GSP3271	Phenix Ave	3335	10	113	0.002	SMH3398	SMH3399	0.237	1.016	489.42	0.705	0.468	-0.311	1.312	-0.607
GSP6474	Cross Country	3448	10	262	0.004	SMH3399	SMH6541	0.237	1.016	597.91	0.861	0.624	-0.155	1.312	-0.451
GSP6475	Cross Country	3710	10	259	0.002	SMH6541	SMH6542	0.238	1.016	489.28	0.705	0.467	-0.312	1.312	-0.608
GSP6476	Cross Country	3969	10	256	0.011	SMH6542	SMH6543	0.238	1.016	1028.31	1.481	1.243	0.464	1.313	0.168
GSP6477	Cross Country	4225	10	300	0.025	SMH6543	SMH6544	0.238	1.016	1565.16	2.254	2.015	1.237	1.312	0.941
GSP6478	Cross Country	4524	10	169	0.025	SMH6544	SMH6545	0.239	1.016	1568.08	2.258	2.019	1.242	1.312	0.946
GSP6479	Cross Country	4693	12	310	0.005	SMH6545	SMH6546	0.254	1.026	1141.54	1.644	1.390	0.618	1.322	0.322
GSP6480	Cross Country	5003	12	192	0.005	SMH6546	SMH6547	0.254	1.026	1138.13	1.639	1.385	0.613	1.322	0.317
GSP6481	Cross Country	5195	12	188	0.005	SMH6547	SMH6548	0.254	1.025	1160.13	1.671	1.416	0.646	1.322	0.349
GSP6482	Cross Country	5383	12	217	0.005	SMH6548	SMH3320	0.255	1.025	1178.26	1.697	1.442	0.672	1.322	0.375
GSP3192	Cross Country	5600	14	272	0.003	SMH3320	SMH3321	0.355	1.096	1231.66	1.774	1.419	0.677	1.394	0.380
GSP3193	Cross Country	5872	14	258	0.003	SMH3321	SMH3322	0.358	1.098	1265.31	1.822	1.464	0.724	1.395	0.427
GSP3194	Cross Country	6130	14	245	0.004	SMH3322	SMH3323	0.361	1.099	1437.90	2.071	1.709	0.971	1.397	0.673
GSP3195	Cross Country	6375	14	242	0.001	SMH3323	SMH3324	0.362	1.099	835.65	1.203	0.842	0.104	1.397	-0.194
GSP3196	Cross Country	6617	14	241	0.003	SMH3324	SMH3325	0.365	1.101	1280.15	1.843	1.478	0.742	1.399	0.444
GSP3206	Curtis St	6858	14	231	0.003	SMH3325	SMH3336	0.378	1.110	1347.13	1.940	1.562	0.830	1.407	0.533
GSP3207	Curtis St	7089	14	182	0.003	SMH3336	SMH3337	0.420	1.139	1253.20	1.805	1.384	0.666	1.433	0.371
GSP3208	Curtis St	7270	14	200	0.002	SMH3337	SMH3332	0.422	1.862	1023.97	1.475	1.053	-0.387	2.157	-0.683
GSP3202	Wine St	7470	14	201	0.004	SMH3332	SMH3331	0.438	1.872	1482.02	2.134	1.696	0.262	2.167	-0.033
GSP3201	Wine St	7671	14	227	0.005	SMH3331	SMH3330	0.441	1.874	1752.71	2.524	2.083	0.650	2.169	0.355
GSP3200	Wine St	7899	14	221	0.009	SMH3330	SMH3329	0.443	1.874	2226.57	3.206	2.764	1.332	2.169	1.037

TABLE 4B
 PROPOSED SEWER MODIFICATION HYDRAULIC MODELING - CHAMPLIN HEIGHTS DEVELOPMENT
 CRANSTON, RI
 PIPES FLOWING 100% FULL

Label	Location	Upstream Pipeline Station (ft)	Diameter (in)	Length (ft)	Slope (ft/ft)	Upstream Manhole	Downstream Manhole	Existing Dry Weather Peak Flow (mgd)	Existing 2-Year Storm Event (3.1") Peak Flow (mgd)	Full Capacity (gpm)	Full Capacity (mgd)	Pre-Development Dry Weather Excess Flow Capacity (mgd)	Pre-Development 2-Year Storm Excess Flow Capacity (mgd)	Post-Development 2-Year Storm Event Peak Flow (mgd)	Post-Development 2-Year Storm Excess Flow Capacity (mgd)
GSP3199	Wine St	8119	14	232	0.014	SMH3329	SMH3328	0.445	1.875	2830.20	4.075	3.631	2.200	2.170	1.906
GSP3198	Wine St	8352	14	230	0.013	SMH3328	SMH3327	0.448	1.877	2797.56	4.028	3.581	2.152	2.171	1.858
GSP7208	Cross Country	8582	14	124	0.006	SMH3327	SMH3326	0.486	1.903	1898.02	2.733	2.248	0.830	2.195	0.538
GSP7207	Cross Country	8706	14	333	0.003	SMH3326	SMH3356	0.486	1.903	1327.78	1.912	1.426	0.009	2.191	-0.279
GSP3197	Cross Country	9040	14	334	0.003	SMH3356	SMH1095	0.512	1.920	1409.44	2.030	1.517	0.110	2.207	-0.178
GSP10235	Cross Country	9374	15	150	0.004	SMH1095	SMH7035	0.522	1.926	1734.10	2.497	1.975	0.571	2.213	0.284
GSP10234	Cross Country	9524	15	288	0.003	SMH7035	SMH7036	0.522	1.925	1758.66	2.532	2.010	0.608	2.211	0.322
GSP10233	Cross Country	9812	15	167	0.005	SMH7036	SMH7037	0.522	1.923	1566.57	2.256	1.734	0.333	2.209	0.047
GSP10232	Cross Country	9978	15	257	0.003	SMH7037	SMH5431	0.522	1.922	1721.34	2.479	1.957	0.557	2.207	0.272
GSP5329	Cross Country	10235	18	192	0.004	SMH5431	SMH5432	0.799	2.774	3120.73	4.494	3.695	1.720	3.060	1.434
GSP5330	Cross Country	10427	18	247	0.004	SMH5432	SMH5433	0.799	3.306	2831.64	4.078	3.278	0.772	3.592	0.486
GSP5331	Cross Country	10674	18	232	0.003	SMH5433	SMH5434	0.802	3.306	2554.54	3.679	2.876	0.373	3.591	0.087
GSP5332	Cross Country	10905	18	202	0.003	SMH5434	SMH5435	0.808	3.308	2414.31	3.477	2.669	0.169	3.592	-0.115
GSP5333	Cross Country	11107	18	212	0.002	SMH5435	SMH5436	0.824	3.317	2289.52	3.297	2.473	-0.020	3.600	-0.304
GSP5334	Cross Country	11319	18	251	0.003	SMH5436	SMH5437	0.824	3.316	2629.13	3.786	2.962	0.470	3.598	0.188
GSP5335	Cross Country	11570	18	261	0.003	SMH5437	SMH5438	0.825	3.314	2624.83	3.780	2.955	0.466	3.595	0.184
GSP5336	Cross Country	11832	18	261	0.004	SMH5438	SMH5428	0.826	3.312	2846.86	4.099	3.274	0.787	3.593	0.507
GSP5323	Sherman Ave	12092	18	58	0.023	SMH5428	SMH5427	1.267	5.950	7096.98	10.220	8.952	4.269	6.712	3.508
CO-29	Sherman Ave	12150	30	24	0.004	SMH5427	WW-17	1.268	5.982	11397.59	16.413	15.145	10.431	6.739	9.674
Deficient Capacity Segments													7		14

Note: Bolded values indicate the sewer segment flow capacity deficit to handle the peak flow including the proposed development.

TABLE 5
CHAMPLIN HILLS AND CHAMPLIN HEIGHTS DEVELOPMENTS
SEWER SEGMENTS WITH DEFICIENT FLOW CAPACITIES

Gavity Sewer ID	Existing Conditions Deficient Flow Capacity (mgd)	Post Champlin Hills Development Deficient Flow Capacity (mgd)	Post Champlin Heights Development Deficient Flow Capacity (mgd)
GSP3167	-	-	0.174
GSP3267	0.045	0.137	0.342
GP20010	-	-	0.034
GSP3270	0.196	0.283	0.493
GSP3271	0.311	0.398	0.607
GSP6474	0.155	0.242	0.451
GSP6475	0.312	0.399	0.608
GSP3195	-	-	0.194
GSP3208	0.387	0.477	0.683
GSP3202	-	-	0.033
GSP7207	-	0.081	0.279
GSP3197	-	-	0.178
GSP5332	-	-	0.115
GSP5333	0.020	0.111	0.304
Total Segments	7	8	14

Note: Deficient Flow Capacities are based on comparing peak flow under the 2-yr storm event condition to the full flow capacity of the sewer segment.

Reference: Sewer System Connection Hydraulic Analysis for the Proposed Champlin Hills and Champlin Heights Residential Developments

REQUIRED SEWER UPGRADES

Champlin Hills Residential Development

As noted above, eight (8) existing sewer segments along the routing of peak sewage flows from the proposed Champlin Hills Residential Development to the Sherman Ave. Pump Station have deficient capacity under a 2 year storm event condition. In order to accommodate the peak flows the 8 deficient sewer segments would require upgrading of their size. **Table 6** lists the 8 hydraulically deficient sewer segments and the required upgraded size to handle the peak tributary flows, including the proposed residential development, at full depth and 60% depth conditions. As seen in **Table 6**, the upgrades for the full depth capacity is one pipe size larger than existing such as upgrading 10" diameter to 12" diameter and 14" diameter to 15" diameter except for GSP3208 on Curtis Street which would require upgrading from 14" diameter to 18" diameter. To achieve capacity at the 60% depth standard, the required upgrades would be 2 pipe sizes larger than existing except for GSP3208 on Curtis Street which would require upgrading from 14" diameter to 21" diameter.

It should be noted, that 7 of the 8 deficient sewer segments for the Champlin Hills proposed development peak flows are currently deficient for the peak 2-yr storm event condition. The proposed development results in the capacity deficiency increasing for those 7 segments. Only the 14" diameter cross-country sewer segment GSP7207 is made deficient by the Champlin Hills development.

Upgrading of the 8 deficient sewer segments for the Champlin Hills Residential Development would require replacing 1,721 linear feet of existing sewers as reported at the bottom of **Table 6**.

Champlin Heights Residential Development

The addition of the Champlin Heights Residential Development to the Champlin Hills Residential Development 2-year storm peak flows results in a total of 14 sewer segments having deficient capacity with 7 of these being currently deficient. **Table 6** lists the 14 hydraulically deficient sewer segments and the required upgraded size to handle the peak tributary flows, including the proposed Champlin Heights residential development in combination with the Champlin Hills residential development, at full depth and 60% depth conditions. In most cases (11 of the 14 segments), the required upgrades for the full depth capacity are one pipe size larger and the remainder being 2 pipe sizes larger. To achieve capacity at the 60% depth standard, the required upgrades would be 2 pipe sizes larger than existing for 10 of the 14 deficient segments. The remaining 4 deficient segments would require 1 pipe size larger.

Upgrading of the 14 deficient sewer segments for the Champlin Heights Residential Development in conjunction with the Champlin Heights Residential Development would require replacing 2,952 linear feet of existing sewers as reported at the bottom of **Table 6**.

**TABLE 6
CHAMPLIN HILLS AND CHAMPLIN HEIGHTS RESIDENTIAL DEVELOPMENTS
CAPACITY DEFICIENT SEWER SEGMENTS REQUIRED UPGRADES**

Label	Location	Pipe Diameter (in.)	Pipe Material	Length	Slope	Full Capacity (gpm)	Max Flow (gpm)	Max Flow / Full Capacity	Upstream Inv	Upstream MH	Down-stream Inv	Down-stream MH	Full Depth Req'd Upgrade Pipe Size (in.)	Upgrade Full Depth Flow Cap. (gpm)	60% Depth Req'd Upgrade Pipe Size (in.)	Upgrade 60% Depth Flow Cap. (gpm)
CHAMPLIN HILLS DEVELOPMENT																
GSP3267	PHENIX AVENUE	10	VC	147	0.0041	633	728	1.15	85.20	SMH3394	84.6	SMH3396	12	1,021	15	1,244
GSP3270	PHENIX AVENUE	10	VC	194	0.0033	569	765	1.35	82.32	SMH3397	81.67	SMH3398	12	924	15	1,126
GSP3271	PHENIX AVENUE	10	VC	113	0.0025	489	766	1.57	81.67	SMH3398	81.39	SMH3399	12	796	15	969
GSP6474	THROUGH PARCELS	10		262	0.0037	598	766	1.28	81.39	SMH3399	80.42	SMH6541	12	972	15	1,184
GSP6475	THROUGH PARCELS	10		259	0.0025	489	766	1.57	80.42	SMH6541	79.78	SMH6542	12	796	15	969
GSP3208	CURTIS STREET	14	VC	200	0.0018	1024	1,355	1.32	53.60	SMH3337	53.24	SMH3332	18	2,001	21	2,028
GSP7207	THROUGH PARCELS	14	AC	333	0.0030	1328	1,384	1.04	42.33	SMH3326	41.32	SMH3356	15	1,596	18	1,744
GSP5333	THROUGH PARCELS	18	AC	212	0.0024	2290	2,367	1.03	34.19	SMH5435	33.69	SMH5436	21	3,454	24	3,313
CHAMPLIN HEIGHTS DEVELOPMENT																
GSP3167	MIDLAND DRIVE	8	VC	231	0.0192	751	872	1.16	89.64	SMH3292	85.2	SMH3394	10	1,362	10	915
GSP3267	PHENIX AVENUE	10	VC	147	0.0041	633	871	1.38	85.20	SMH3394	84.6	SMH3396	12	1,021	15	1,244
GP20010	PHENIX AVENUE	10	CI	22	0.0074	848	871	1.03	82.48	SMH3396	82.32	SMH3397	12	1,378	12	926
GSP3270	PHENIX AVENUE	10	VC	194	0.0033	569	911	1.60	82.32	SMH3397	81.67	SMH3398	12	924	15	1,126
GSP3271	PHENIX AVENUE	10	VC	113	0.0025	489	911	1.86	81.67	SMH3398	81.39	SMH3399	15	1,443	15	969
GSP6474	THROUGH PARCELS	10		262	0.0037	598	911	1.52	81.39	SMH3399	80.42	SMH6541	12	972	15	1,184
GSP6475	THROUGH PARCELS	10		259	0.0025	489	911	1.86	80.42	SMH6541	79.78	SMH6542	15	1,443	15	969
GSP3195	THROUGH PARCELS	14	VC	242	0.0012	836	970	1.16	55.78	SMH3323	55.49	SMH3324	15	1,004	18	1,097
GSP3208	CURTIS STREET	14	VC	200	0.0018	1024	1,498	1.46	53.60	SMH3337	53.24	SMH3332	18	2,001	21	2,028
GSP3202	WINE STREET	14	AC	201	0.0038	1482	1,505	1.02	53.24	SMH3332	52.48	SMH3331	15	1,781	18	1,946
GSP7207	THROUGH PARCELS	14	AC	333	0.0030	1328	1,522	1.15	42.33	SMH3326	41.32	SMH3356	15	1,596	18	1,744
GSP3197	THROUGH PARCELS	14	AC	334	0.0034	1409	1,533	1.09	41.32	SMH3356	40.18	SMH1095	15	1,694	18	1,851
GSP5332	THROUGH PARCELS	18	AC	202	0.0026	2414	2,494	1.03	34.72	SMH5434	34.19	SMH5435	21	3,642	24	3,493
GSP5333	THROUGH PARCELS	18	AC	212	0.0024	2290	2,500	1.09	34.19	SMH5435	33.69	SMH5436	21	3,454	24	3,313

TOTAL LENGTH OF REQUIRED UPGRADES CHAMPLIN HILLS 1,721 ft
TOTAL LENGTH OF REQUIRED UPGRADES CHAMPLIN HEIGHTS 2,952 ft

Reference: Sewer System Connection Hydraulic Analysis for the Proposed Champlin Hills and Champlin Heights Residential Developments

CONCLUSIONS

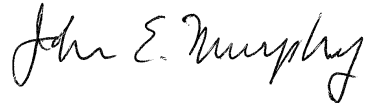
Our evaluation of the proposed development and peak sewage flows from the Champlin Hills and Champlin Heights connection to the Cranston sewer system has determined the following conclusions:

- The Champlin Hills Residential Development of 63 dwelling units will produce a peak daily flow of 77,679 gpd (54 gpm) and the Champlin Heights Residential Development of an additional 150 dwelling units will produce a peak daily flow of 176,850 gpd (123 gpm) for a combined peak daily flow of 254,529 gpd (177 gpm).
- The Champlin Hills Development peak daily flows added to the existing 2-year storm event wastewater flows would result in 8 manhole-to-manhole sewer segments exceeding their full depth capacity. Under existing conditions, the full depth capacity for 7 of the 8 sewer segments is currently exceeded with the 2-year storm event conditions.
- The Champlin Heights Development peak daily flows together with the Champlin Hills Development peak daily flows added to the existing 2-year storm event wastewater flows would result in 14 sewer segments exceeding their full depth capacity. Under existing conditions, the full depth capacity for 7 of the 14 sewer segments is currently exceeded with the 2-year storm event conditions.
- The peak flow capacity deficits for the Champlin Hills Development range from 0.081 mgd to 0.477 mgd for the 8 pipe segments and the peak flow capacity deficits for the Champlin Heights Development range from 0.033 mgd to 0.683 mgd for the 14 pipe segments.
- The estimated post-development peak flow (2-year storm) at the Sherman Ave. Pump Station is 6.075 mgd for Champlin Hills and 6.739 mgd for both Champlin Hills and Champlin Heights combined. These peak flows are well within the 9.0 mgd safe pumping capacity of the Sherman Ave Pump Station.
- The 8 deficient capacity sewer segments for the Champlin Hills Development require upgrades in size to accommodate the 2-year storm event peak flow including the development peak daily flow. The 8 sewer segments requiring upgrades total 1,721 feet in length and range in size from 12" to 21" for meeting the full depth capacity and 15" to 24" for meeting the 60% depth capacity standard.
- The 14 deficient capacity sewer segments for the Champlin Heights Development in combination with the Champlin Hills Development require upgrades in size to accommodate the 2-year storm event peak flow including the development peak daily flow. The 14 sewer segments requiring upgrades total 2,952 feet in length and range in size from 12" to 21" for meeting the full depth capacity and 15" to 24" for meeting the 60% depth capacity standard.

Reference: Sewer System Connection Hydraulic Analysis for the Proposed Champlin Hills and Champlin Heights Residential Developments

If you have any questions or comments on this sewer system hydraulic analysis or our findings, please contact me by phone or e-mail.

STANTEC CONSULTING SERVICES INC.



John E. Murphy, P.E., BCEE
Senior Associate
978/577-1407
john.murphy@stantec.com

APPENIDIX 1

Sewer Use Calculations

Champlin Hills and Champlin Heights Residential Developments

Garofalo & Associates, Inc.



Garofalo & Associates, Inc.

Consulting Engineers

Surveyors ♦ Land Planners

April 10, 2015

John E. Ayotte
Underground Asset Manager/Collections Engineer
Veolia Water North America
140 Pettaconsett Avenue
Cranston, RI 02920


Re: Sewer Plan Review
Calculation Revisions
Champlin Hills / Champlin Heights
A.P. 20-4, Lots 2117 and 2128 and
A.P. 12-6, Lot 3108
Scituate Avenue
Cranston, RI

Dear Mr. Ayotte,

As requested, I've modified the expected sewer usage to reflect the average daily flows outlined in the Rhode Island Department of Environmental Management, Flow Estimation Policy for Design of Sanitary Sewers. Please refer to the attached calculation for conformance to your requirements.

Should you require additional information please call.

Sincerely,
Garofalo & Associates, Inc.



Richard J. Bourbonnais, II, RLA, PE
Project Manager

cc. Carpionato Properties, File



Sewer Use Calculations

Champlin Hills Residential Development

**ASSESSORS PLAT 20/4, LOTS 2117 AND 2128
AND A.P. 12-6, LOT 3108
SCITUATE AVENUE
CRANSTON, RHODE ISLAND**

Owner/Applicant:

**West Bay, LLC
1414 Atwood Avenue
Cranston, Rhode Island 02919**

Prepared by:



GAROFALO

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Sewer Use
Project: Champlin Hills

A.P. 20-4, Lot 2117

Garofalo Project Number: 6856.00

Description: Multi-unit Residential Development, proposed (63) 2-bedroom dwelling units.

proposed: **63 dwelling units**

estimated Average Daily Flow (ADF): **300 gal / unit / day***

Average Daily Flow: 300 gal/Unit/Day x 63 Units = **18,900 gpd**

Peak Daily Flow:

$$*Q_{\text{peak}} / Q_{\text{avg.}} = \frac{18 + \sqrt{P}}{4 + \sqrt{P}} \quad \text{where } P = \text{population in thousands} = 0.252$$

(2 persons / bedroom / dwelling unit = 2 x 2 x 63 = 252 persons)

$$Q_{\text{peak}} / Q_{\text{avg.}} = (18 + \sqrt{0.252}) / (4 + \sqrt{0.252}) = \mathbf{4.11}$$

$$Q_{\text{avg}} = 18,900 \text{ gpd}$$

$$Q_{\text{peak}} / 18,900 \text{ gpd} = 4.11$$

Peak Daily Flow (Q_{peak}) = 77,679 gpd

Maximum Hourly Flow:

$$77,679 \text{ gpd} / 24 \text{ hours per day} = \mathbf{3,236.63 \text{ gph}}$$

$$\text{Max Flow: } 3,236.63 \text{ gph} / 60 \text{ min per hour} = 53.94 \text{ gpm}$$

$$53.94 \text{ gpm} / 60 \text{ sec per min} = 0.899 \text{ gps}$$

$$0.899 \text{ gps} \times 0.13368 \text{ cf/gal} = \mathbf{0.12 \text{ cfs}}$$

* Reference the Flow Estimation policy for Design of Sanitary Sewers (RIDEM)



Sewer Use

Project: Champlin Heights

A.P. 20-4, Lot 2128 and A.P. 12-6, Lot 3108

Garofalo Project Number: 6856.01

Description: Multi-unit Residential Development, proposed (150) 2-bedroom dwelling units.

proposed: **150 dwelling units**

estimated Average Daily Flow (ADF): **300 gal / unit / day***

Average Daily Flow: 300 gal/Unit/Day x 150 Units = **45,000 gpd**

Peak Daily Flow:

$$*Q_{\text{peak}} / Q_{\text{avg.}} = \frac{18 + \sqrt{P}}{4 + \sqrt{P}} \quad \text{where } P = \text{population in thousands} = 0.6$$

(2 persons / bedroom / dwelling unit = 2 x 2 x 150 = 600 persons)

$$Q_{\text{peak}} / Q_{\text{avg.}} = (18 + \sqrt{0.6}) / (4 + \sqrt{0.6}) = \mathbf{3.93}$$

$$Q_{\text{avg}} = 45,000 \text{ gpd}$$

$$Q_{\text{peak}} / 45,000 \text{ gpd} = 3.93$$

Peak Daily Flow (Q_{peak}) = 176,850 gpd

Maximum Hourly Flow:

$$176,850 \text{ gpd} / 24 \text{ hours per day} = \mathbf{7,368.75 \text{ gph}}$$

$$\text{Max Flow: } 7,368.75 \text{ gph} / 60 \text{ min per hour} = 122.81 \text{ gpm}$$

$$122.81 \text{ gpm} / 60 \text{ sec per min} = 2.047 \text{ gps}$$

$$2.047 \text{ gps} \times 0.13368 \text{ cf/gal} = \mathbf{0.274 \text{ cfs}}$$

* Reference the Flow Estimation policy for Design of Sanitary Sewers (RIDEM)

