

3.0 FIELD INVESTIGATIONS AND DATA COLLECTION

This Chapter presents the field investigation and data collection activities performed in the Wellington Avenue CSO Facility's tributary catchments as part of this Phase 1, Part 1, which included the following:

- Flow metering
- Rainfall monitoring
- Groundwater monitoring
- Tidal monitoring
- Physical survey of the Thames Street Interceptor: manhole inspections and line lamping.

3.1 METERING OF WASTEWATER FLOWS

The flow metering program was designed to provide a general understanding of the hydraulics of the sewerage catchment areas tributary to the Thames Street Interceptor, to evaluate the dry weather and wet weather flow characteristics of each metered catchment area, and to determine infiltration and inflow sensitivity of each tributary catchment.

The program included measurement of flows in eight tributary catchment areas to the Thames Street Interceptor. For each area, the tributary collection systems were evaluated through mapping and field verification to identify a metering manhole through which all wastewater from the tributary area is conveyed. Once the metering manholes were identified, Severn Trent Pipeline Services, Inc. (STPS) installed nine flow meters. The location, tributary catchment area, and the size of the pipe for each flow meter are presented in Table 3.1. A flow schematic that depicts the relationship of each of the flow meters and groundwater gauges (GWG) for the study area is presented in Figure 3.1. Dry and wet weather sewage flows typically follow the same path in the schematic, with the exception of flows from Catchment Area 1. Sewage flow from Catchment Area 1 during dry weather periods travels in a westward direction to the Thames Street Interceptor via the Narragansett Storage Conduit. During wet weather, sewage from Catchment Area 1 flows through the Narragansett Storage Conduit until flow depths at the Wellington Avenue CSO Facility rise to a preset level.

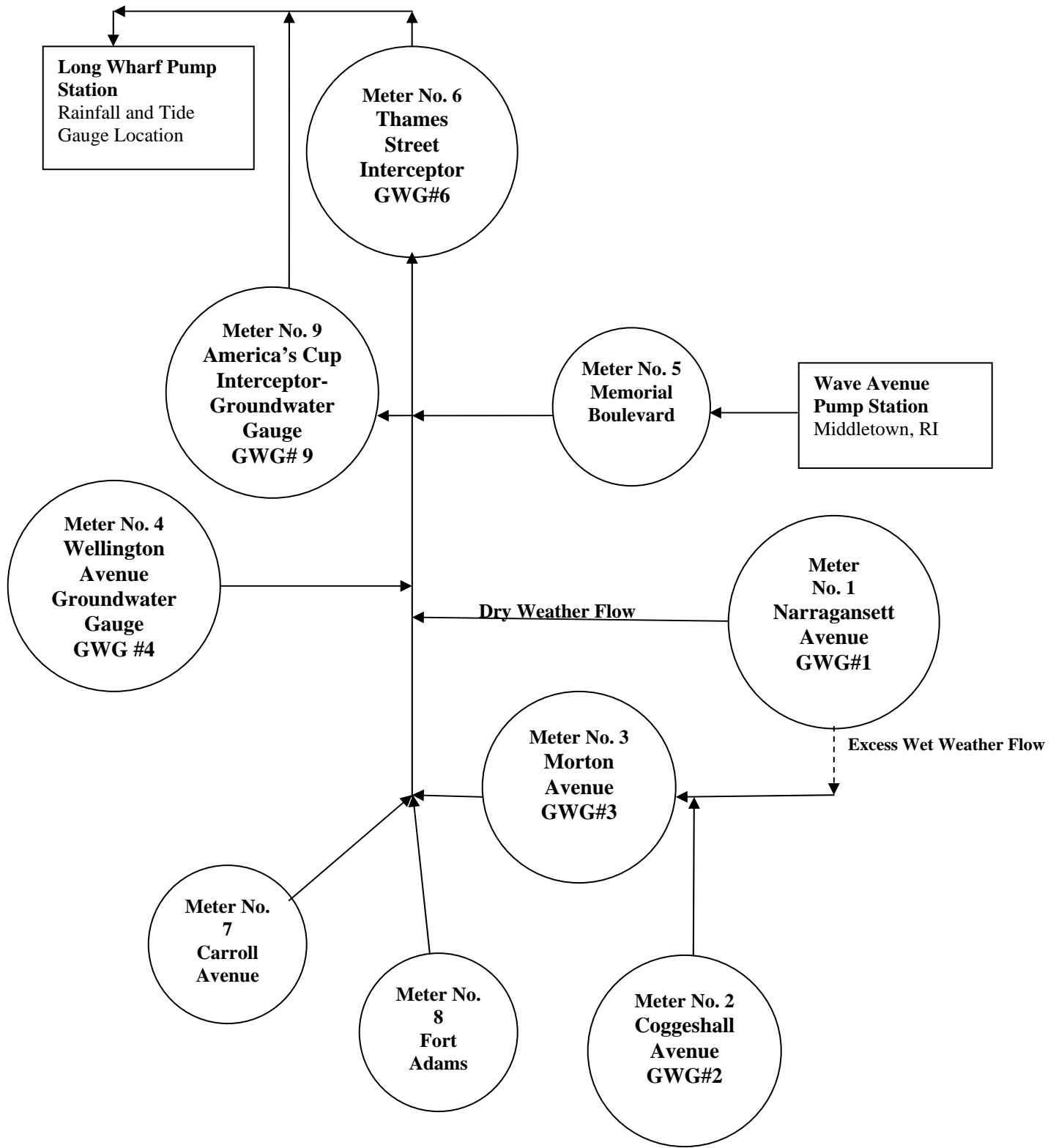


FIGURE 3.1: Flow Metering Schematic

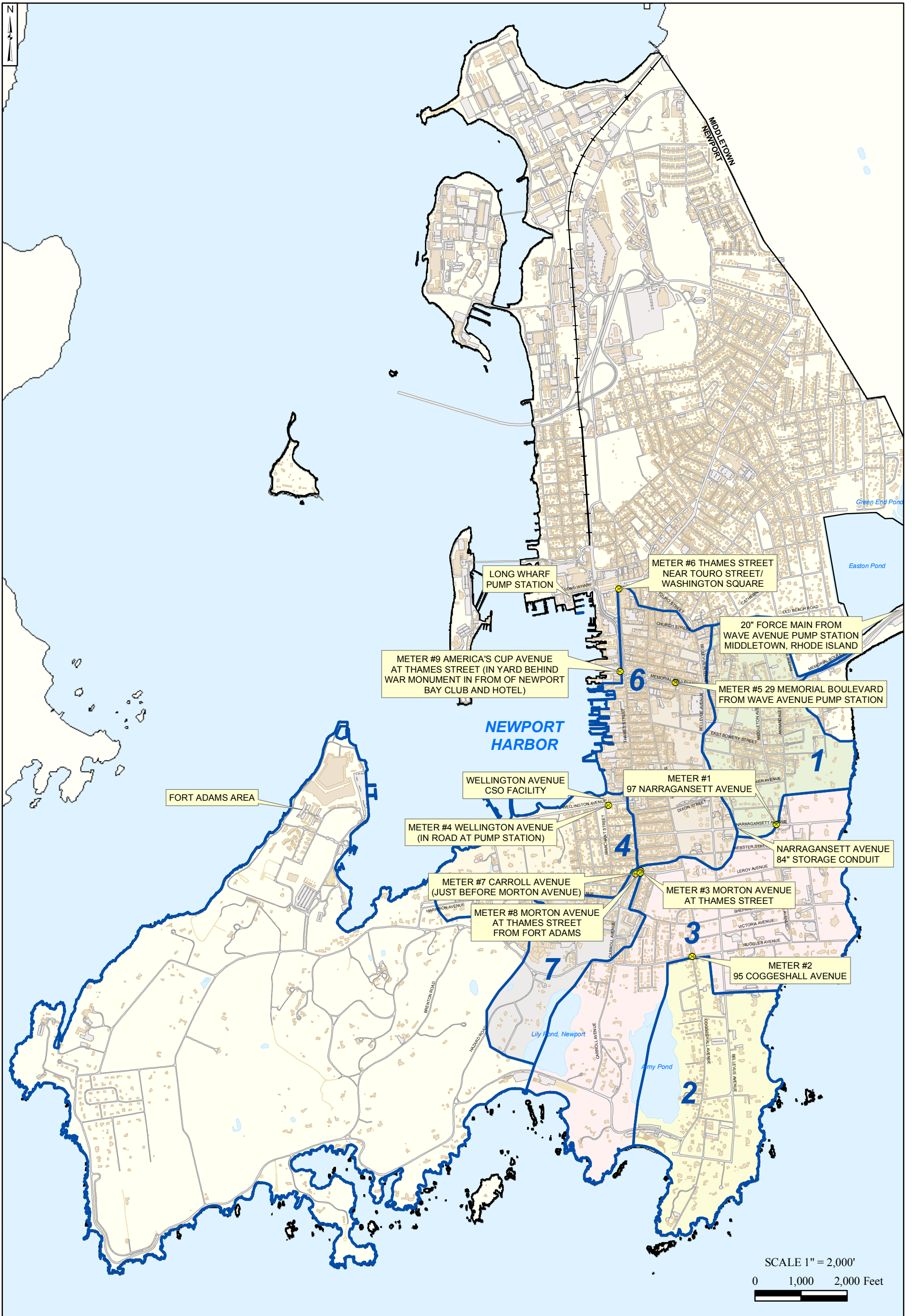
When the threshold level is reached at Wellington Avenue, a gate at the western end of the Narragansett Storage Conduit closes to permit the detention of sewage flows from Catchment Area 1. When the Storage Conduit reaches it's capacity, additional wet weather sewage flow from Catchment Area 1 flow east in Narragansett Avenue to Ochre Point Avenue. The flow continues to Ruggles Avenue through Morton Park and Catchment Area 3 to the Thames Street Interceptor. The meter locations and tributary catchment areas are presented in Figure 3.2 Flow Meter Locations and Sewer Catchments.

**TABLE 3.1
METER LOCATIONS, PIPE AND CATCHMENT AREA DATA**

Meter No.	Meter Location	Tributary Catchment Area (Acres)	Primary Land Use	Number of Buildings	Number of Sanitary Manholes	Length of Sanitary Sewer Pipe (feet)
1	Opposite 97 Narragansett Avenue	223	Residential	723	115	32,228
2	95 Coggeshall Avenue	288	Residential	311	61	15,290
3	Corner of Morton Ave and Thames St. Near Morton Park	516	Mixed use	595	123	33,660
4	Wellington Ave. (upstream of Wellington Avenue CSO Facility)	185	Residential	690	92	22,670
5	29 Memorial Blvd.	Force Main from Wave Ave. Pump Station, Middletown, RI	N/A	N/A	N/A	N/A
6	Thames Street near Washington Square	271	Mixed Use	1,354	212	57,610
7	7 Carroll Avenue near Morton Avenue	143	Mixed Use	304	58	13,536
8	Corner of Morton Ave and Thames Street	Force Main from Fort Adams	Residential	N/A	N/A	N/A
9	America's Cup Ave. at Thames Street	N/A, See Note 1	Mixed Use	N/A	N/A	N/A
Totals		1,626		3,977	661	174,994

Notes:

1. Flow Meter 9 was installed to measure flows discharging from the high level connection of the Thames Street Interceptor to the sewer on Americas Cup Avenue.
2. The total acreage of the metered catchments (excludes pump stations) as shown previously on Table 2.1 is 1,626 acres.



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- LEGEND:**
- Proposed Metering Locations
 - Sewer District Boundaries
 - Buildings
 - Docks
 - Paved Roads and Parking
 - Unpaved Roads and Parking

FIGURE 3.2
FLOW METER LOCATIONS
AND SEWER CATCHMENTS
PHASE I PART I CSO CONTROL PLAN

The flow meters were installed between March 28 and March 31, 2005 and recorded data until May 5, 2005, at which time they were removed. The meters measured depth and velocity and recorded the data at 15-minute intervals in the meter's computer memory. The recorded data were uploaded from the meters periodically using a laptop computer. During the metering period, the meters were checked weekly for routine maintenance to ensure that they were operating properly. The routine maintenance inspections indicated that the meters were operating as intended and that any minor problems encountered were corrected.

During the metering period, meters at locations 1, 7, and 8 experienced surcharging during a period of time for one or more of the wet weather events. Details of the surcharge events are presented in Table 3.2.

TABLE 3.2
SUMMARY OF SURCHARGE EVENTS DURING THE METERING PERIOD

Meter No.	Location	Description of Surcharge
1	Opposite 97 Narragansett Avenue	Site experienced surcharged conditions from 4/2/05 at 10:00 AM to 12:30 PM
7	7 Carroll Avenue near Morton Avenue	Site experienced surcharged conditions from 4/2/05 at 10:30 to 11:30 AM and from 4/30/05 at 10:45 to 11:30 PM.
8	Corner of Morton Ave and Thames Street	Site experienced surcharged condition from 4/2/05 at 10:30 AM to 12:15 PM and from 4/30/05 at 11:00 to 11:40 PM.

In addition, Meter 3 failed on April 29th, 2005 at 10:15 AM. However, since flows from Meters 1 and 2 flow through Meter 3, we were able to extrapolate the missing flow data for Meter 3 by reviewing the flow data for the entire metering period for Meters 1, 2 and 3 and determining a weighted average for both wet and dry weather periods for each catchment area such that we could estimate with reasonable certainty the flow in Meter 3 during the period.

Appendix B presents the flow hydrographs for each of the metered Catchment Areas for the flow metering period.

3.1.1 CSO Events During the Metering Period

The City experienced three CSO discharges from the Wellington Avenue CSO Facility immediately prior to and during the metering period. A summary of the CSO discharges is presented in Table 3.3.

**TABLE 3.3
WELLINGTON AVENUE CSO FACILITY DISCHARGES
DURING FLOW METERING PERIOD**

Discharge Commenced		Discharge Concluded		Duration	Volume	Total
Date	Time	Date	Time	Hours	(gallons)	Rainfall (in.)
3/28/2005	7:32 P.M.	3/31/2005	6:00 A.M.	58.5	2,920,770	2.56
4/2/2005	8:30 A.M.	4/4/2005	9:30 P.M.	61	2,412,810	1.85
4/30/2005	11:50 P.M.	5/1/2005	2:00 P.M.	14	711,144	2.04

3.2 RAINFALL MONITORING

Rainfall data were obtained from a tipping bucket collector rain gauge with an electronic data logger installed by STPS on the roof of the Long Wharf Pump Station. Rainfall was recorded in 15-minute intervals during the entire flow metering period. During the metering period, three rainfall events were measured and are summarized in Table 3.4.

**TABLE 3.4
RAINFALL SUMMARY**

Start	Finish	Peak Hour Intensity (in/hr)	Total Rainfall (in)	Duration (hrs)
4/2/2005	4/3/2005	0.34	1.85	25.25
4/8/2005	4/8/2005	0.22	0.8	6.5
4/30/2005	5/1/2005	0.63	2.04	24.5

3.3 GROUNDWATER AND TIDAL MONITORING

The tide level in Newport Harbor was measured using a tide gauge at the Long Wharf pumping station. Groundwater data were obtained at six locations (numbered to coincide with the flow meter) using piezometric groundwater gauges installed through the manhole wall at the top of the manhole shelf. At two locations, groundwater data were obtained and recorded continuously by reading the piezometric gauge using a pressure sensor and then recording the data in the data logger's computer memory. The recorded data were then uploaded from the data logger to a

laptop computer. The data loggers were checked weekly to retrieve the recorded data. The continuous groundwater data were recorded every fifteen minutes during the monitoring period. In addition to the two continuous groundwater monitoring locations, groundwater levels were monitored at four additional manholes, at meter locations 1, 2, 3 and 6. The non-continuous groundwater levels were monitored by manually reading the piezometric groundwater gauges installed through the manhole wall. Manual readings were at approximately weekly intervals during the metering period. The locations of the groundwater gauges are presented in Figure 3.1.

The continuous groundwater gauges, GWG #4 and GWG #9, were located in meter manholes 4 and 9, respectively. Ground water levels at GWG #4 fluctuated between about 12 inches and 27 inches above the pipe during the data collection period. Fluctuations in the groundwater level were consistent with the tidal activity in Newport Harbor. Further discussion regarding tidal impacts at this location is presented in Chapter 4 of this report.

The groundwater levels recorded by GWG #9 did not rise above the gauge's vertical section that penetrated the manhole wall, despite the gauge being installed as low as possible in the manhole. Similarly, the static groundwater gauges installed at meter manholes 1, 2, and 3 showed no groundwater above the pipe at any of the locations despite being placed as low in the manhole as possible.

Appendix C presents the groundwater monitoring data at the individual measured locations.

3.4 THAMES STREET INTERCEPTOR PHYSICAL SURVEY

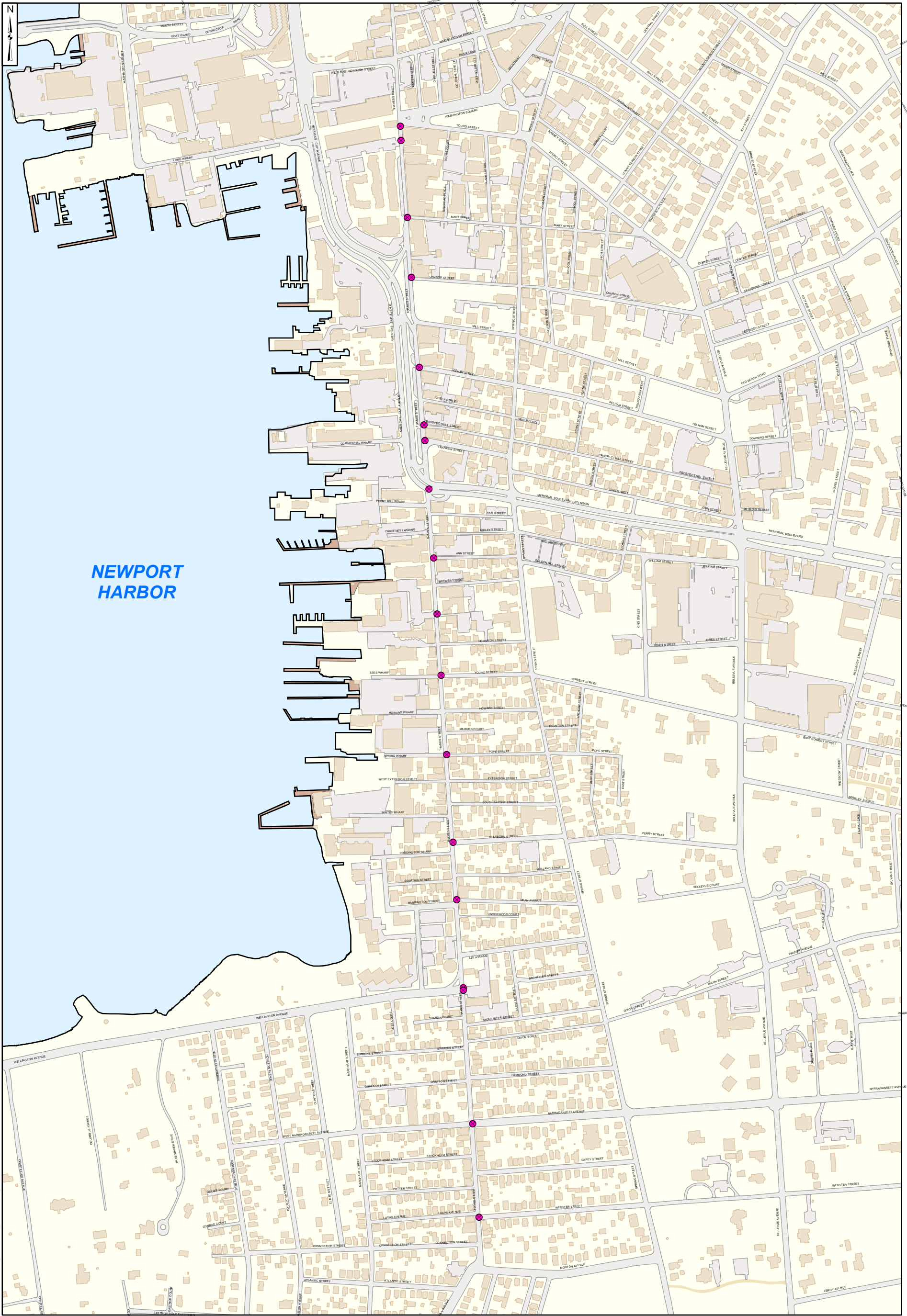
The major interceptor serving Newport's collection system is the brick, egg-shaped, three-foot by four-foot Thames Street Interceptor. The interceptor contains various diversion structures, including those at the intersection of Thames Street and Wellington Avenue, which consists of a plate and a weir, and was designed to regulate flows up to 3 mgd in the egg-shaped interceptor. A five-foot side weir is placed 1.25 feet above the invert of the interceptor and a diversion plate is located downstream of this weir. The bottom plate is also 1.25 feet above the invert of the interceptor. This flow regulating structure diverts combined sewage flow to the Wellington Avenue CSO Facility, and prevents the downstream capacity of the egg-shaped interceptor from being exceeded. Two additional diversion structures are located at Franklin Street and Young Street. The diversion structure at Young Street was originally constructed to divert high flows to the Lee's Wharf outfall to Newport Harbor. It was intended to be disconnected during the sewer

separation projects constructed in the late 1970s. This cross connection was inspected and verified during the manhole inspections performed in January 2005 by Severn Trent Pipeline Services (STPS). Upon discovery as part of this study that this cross connection still existed, the City installed a plug to prevent the discharge of flows to the Lee's Wharf outfall.

Seventeen manholes on the Thames Street Interceptor were inspected via manned entry. The inspection process consisted of physically entering each manhole and visually inspecting the manhole cover, corbel, frame, walls, base, and all incoming and outgoing pipes. The upstream and downstream sewer lines connected to the manholes were inspected by lamping, making note of the various defects and indication of infiltration. The purpose of this inspection was to determine the actual physical condition of the manhole and pipe segments of the sewer system, and to identify defects and/or hydraulic restrictions that may be causing excessive infiltration, sanitary sewer overflows, or contributing to CSOs at the Wellington Avenue CSO Facility. Figure 3.3 depicts the manholes where inspections were performed.

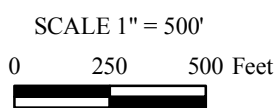
The manhole inspections produced the following information:

- General cover data including type, diameter, fit, and evidence of inflow
- General manhole data including manhole number, depth, and diameter
- Frame and riser information including type, diameter, height, and evidence of inflow
- Wall information including materials of construction, presence and condition of corbel and steps, evidence of infiltration, staining, salt deposits, surcharging, high water marks, and rehabilitation recommendations
- Invert/shelf information including condition, evidence of infiltration, orientation, direction of flow, a sketch, and rehabilitation recommendations
- Line lamping information for all incoming and outgoing lines including material type, diameter, inches of debris observed, debris type, structural condition, evidence of corrosion, hydraulic restrictions, evidence of infiltration, sluggish flow or wastewater backing up in the manhole, and depth from ground surface to top of invert
- Photographs of the manhole and interceptor.



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- LEGEND:
- Inspected Manhole
 - Buildings
 - Docks
 - Paved Roads and Parking
 - Unpaved Roads and Parking

FIGURE 3.3
THAMES STREET INTERCEPTOR
MANHOLE INSPECTION LOCATIONS
PHASE I PART I CSO CONTROL PLAN

Review of the individual manhole inspection reports noted the following:

- The manholes are generally in good condition with only minor cracks were encountered in the walls. Typically, pipe inverts were submerged during the inspection.
- The inspections discovered some loose or missing bricks, missing mortar, and rusted steel in corbels in fourteen of the seventeen manholes inspected.
- The inspections discovered cracks in the upstream and downstream sewer lines in the Thames Street Interceptor and the side sewers entering and exiting the manholes in five of the seventeen manholes. Cracks in the connections are most likely a source of infiltration due to the inspected manholes' proximity to Newport Harbor.
- As shown in the following photographs, the inspections of the diversion structures at Wellington Avenue, at Franklin Street, and Young Street confirmed that flows were restricted using inverted weir plates and at two additional locations flows were restricted by cast iron pipes penetrating the interceptor.



PHOTOGRAPH 3.1: Upstream view of 42-inch Restrictor Plate at Wellington Avenue Diversion Structure



PHOTOGRAPH 3.2: Upstream view of a cast iron pipe running through the crown of the interceptor at Dean Street.

Appendix D includes the detailed manhole inspection report prepared by STPS containing inspection reports and photographic documentation of defects encountered.

3.4.1 Estimate of Full Flow Capacity of the Thames Street Interceptor

Based on the results of the manhole inspections, Earth Tech estimated the full flow capacity of each segment of the Thames Street Interceptor for both unrestricted and restricted (i.e., weir plates at the three diversion structures) conditions using Manning's equation. The results of the calculation for each of the segments are summarized in Table 3.5. It is noted that the restrictor plates installed at the intersections of Wellington Avenue, Franklin Street and Young Street restrict the full flow capacity by 30% to 50% in certain locations.

TABLE 3.5
Thames Street Interceptor – Full Flow Capacity Estimate

Manning Equation roughness coef, n = 0.016																								
Sect.	Downstream Manhole	MH ID	Invert	Upstream Manhole	MH ID	Invert	Length	Slope	Shape	Height	x	Width	Material	Area (ft^2)	Hydr. Rad	Velocity (ft/s)	Estimate of Full Flow Capacity (mgd)	Area Restrict. (%)	Area with Restriction (ft^2)	Hydr. Radi	Velocity (ft/s)	Estimate of Restricted Flow Capacity (mgd)	Notes	
2	Mid block Touro/Mary	SMH-071-12	3.24	Mary Street	SMH-071-15	3.39	250	0.00060	EGG	48	x	36	Brick	9.25	0.840	2.03	12.11		9.25	0.84	2.03	12.11		
3	Mary Street	SMH-071-15	3.39	Church Street	SMH-079-44	3.8	330	0.00124	EGG	48	x	36	Brick	9.25	0.840	2.91	17.42		9.25	0.84	2.91	17.42		
4	Church Street	SMH-079-44	3.8	Mill Street	Not shown	4.14	255	0.00133	EGG	48	x	36	Brick	9.25	0.840	3.02	18.05	15%	7.86	0.78	2.87	14.60	CI pipe @ 6'. 15% restriction. MH not shown on GIS	
5	Mill Street	Not shown	4.14	Pelham Street	SMH-079-45	4.19	235	0.00021	EGG	48	x	36	Brick	9.25	0.840	1.21	7.21		9.25	0.84	1.21	7.21		
6	Pelham Street	SMH-079-45	4.19	Green Street	SMH-079-46	4.51	175	0.00183	EGG	48	x	36	Brick	9.25	0.840	3.54	21.14		9.25	0.84	3.54	21.14		
7	Green Street	SMH-079-46	4.51	Prospect Hill Street	SMH-086-25	4.57	140	0.00048	EGG	48	x	36	Brick	9.25	0.840	1.80	10.79		9.25	0.84	1.80	10.79	Assumed Pipe Size	
8	Prospect Hill Street	SMH-086-25	4.576 667	Franklin Street	SMH-087-23	4.61	85	0.00039	EGG	48	x	36	Brick	9.25	0.840	1.64	9.79	30%	6.49	0.66	1.39	5.84	Restrictor plate to 15" below crown	
9	Franklin Street	SMH-087-23	4.61	Fair Street	SMH-087-3	5.04	420	0.00102	EGG	48	x	36	Brick	9.25	0.840	2.65	15.82		9.25	0.84	2.65	15.82	Assumed Pipe Size	
10	Fair Street	SMH-087-3	5.04	Gidley Street	SMH-087-1	5.1	100	0.00060	EGG	48	x	36	Brick	9.25	0.840	2.03	12.11		9.25	0.84	2.03	12.11	Assumed Pipe Size	
11	Gidley Street	SMH-087-1	5.1	Ann Street	SMH-087-5	5.22	125	0.00096	EGG	48	x	36	Brick	9.25	0.840	2.56	15.31		9.25	0.84	2.56	15.31		
12	Ann Street	SMH-087-5	5.22	Brewer Street	SMH-093-38	5.23	145	0.00007	EGG	48	x	36	Brick	9.25	0.840	0.69	4.10		9.25	0.84	0.69	4.10		
13	Brewer Street	SMH-093-38	5.23	Newton Court	SMH-093-37	5.2	165	0.00018	EGG	48	x	36	Brick	9.25	0.840	-	-		9.25	0.84	-	-	-	Inverse slope
14	Newton Court	SMH-093-37	5.2	Dennison Street	SMH-093-36	5.36	155	0.00103	EGG	48	x	36	Brick	9.25	0.840	2.66	15.88		9.25	0.84	2.66	15.88		
15	Dennison Street	SMH-093-36	5.36	Young Street	SMH-093-30	5.64	170	0.00165	EGG	48	x	36	Brick	9.25	0.840	3.36	20.06	43%	5.25	0.58	2.63	8.94	Restrictor Plate to 20" below crown, cross connection to SD outfall	
16	Young Street	SMH-093-30	5.64	Pope Street	SMH-100-6	6.06	440	0.00095	EGG	48	x	36	Brick	9.25	0.840	2.55	15.27		9.25	0.84	2.55	15.27	CI Pipe through crown.	
17	Pope Street	SMH-100-6	6.06	South Baptist Street	SMH-100-4	6.24	265	0.00068	EGG	48	x	36	Brick	9.25	0.840	2.15	12.88		9.25	0.84	2.15	12.88		
18	South Baptist Street	SMH-100-4	6.24	Dearborn Street	SMH-100-2	6.61	210	0.00176	EGG	48	x	36	Brick	9.25	0.840	3.47	20.75		9.25	0.84	3.47	20.75		
19	Dearborn Street	SMH-100-2	6.61	Holland Street	SMH-100-9	6.79	175	0.00103	EGG	48	x	36	Brick	9.25	0.840	2.65	15.85		9.25	0.84	2.65	15.85		
20	Holland Street	SMH-100-9	6.79	Dean Avenue	SMH-100-6A	6.87	130	0.00062	EGG	48	x	36	Brick	9.25	0.840	2.05	12.26		9.25	0.84	2.05	12.26		
21	Dean Avenue	SMH-100-6A	6.87	Lee Avenue	SMH-110-47	7.24	300	0.00123	EGG	48	x	36	Brick	9.25	0.840	2.90	17.36		9.25	0.84	2.90	17.36		
22	Lee Avenue	SMH-110-47	7.24	Wellington Avenue	SMH-110-46	7.38	145	0.00097	EGG	48	x	36	Brick	9.25	0.840	2.57	15.36		9.25	0.84	2.57	15.36	Assumed Pipe Size	
23	Wellington Avenue	SMH-110-46	7.38	Wellington Avenue	SMH-110-45	7.44	40	0.00150	EGG	48	x	36	Brick	9.25	0.840	3.20	19.14	43%	5.25	0.58	2.51	8.53	Assumed Pipe Size - with Restrictor plate to 20" as shown in SMH-110-45	
24	Wellington Avenue	SMH-110-45	7.44	Wellington Avenue	SMH-110-44	7.55	20	0.00550	EGG	48	x	36	Brick	9.25	0.840	6.13	36.66	72%	2.64	0.38	3.60	6.13	Restrictor Plate to 32" below Crown	
25	Wellington Avenue	SMH-110-44	7.55	Dixon Street	SMH-110-40	7.84	280	0.00104	EGG	48	x	36	Brick	9.25	0.840	2.66	15.91		9.25	0.84	2.66	15.91		
26	Dixon Street	SMH-110-40	7.84	Hammond Street	SMH-110-39	7.96	195	0.00062	EGG	48	x	36	Brick	9.25	0.840	2.05	12.26		9.25	0.84	2.05	12.26	Assumed Pipe Size	
27	Hammond Street	SMH-110-39	7.96	Narragansett Avenue	SMH-118-2	8.13	255	0.00067	EGG	48	x	36	Brick	9.25	0.840	2.13	12.76		9.25	0.84	2.13	12.76		
28	Narragansett Avenue	SMH-118-2	8.13	Narragansett Avenue	SMH-118-128	8.14	10	0.00100	EGG	48	x	36	Brick	9.25	0.840	2.61	15.63		9.25	0.84	2.61	15.63		
29	Narragansett Avenue	SMH-118-128	8.14	Carey Street	SMH-118-7	8.45	260	0.00119	EGG	34	x	38	Brick	7.04	0.740	2.62	11.94		7.04	0.74	2.62	11.94	Assumed Pipe Size	
30	Carey Street	SMH-118-7	8.45	Webster Street	SMH-118-8	8.54	240	0.00037	EGG	34	x	38	Brick	7.04	0.740	1.47	6.70		7.04	0.74	1.47	6.70		