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Via Electronic Mail

April 17, 2022

Michael S. Riley, P.E.
CSO Abatement Coordinator
Maine Department of Environmental Protection
17 State House Station
Augusta, ME 04333-0017

Woodard & Curran

Re: South Portland's CSO Master Plan Update (MPU)

Dear Michael:

Thank you for coordinating the review of the CSO MPU for the City of South Portland. In response to Maine DEP's November 15, 2021 memorandum, we have performed the following additional detailed analysis:

- Updated the existing 1-dimensional SWMM model of the combined sewer system to account for a greater level of interaction between the combined system and the separated storm drain system, as well as the tidal elevation during larger storms (>2-year design storms);
- Identified and evaluated alternatives to prevent overflows from the west side of the collection system from discharging into sensitive receiving waters (CSO #005 and CSO #006) during larger storm events (5-year and 10-year);
- Re-evaluated the current control level on the east side of the collection system (CSO #018); and
- Performed a Financial Capability Analysis to determine the City's financial capacity to implement the revised CSO abatement recommendations.

The results of the additional detailed analysis identified an alternative that achieves a 5-year control level at CSOs discharging to sensitive receiving waters (CSO #005 and CSO #006) without adding considerable additional burden on the rate payers.

Enclosed, please find a copy of the revised CSO Master Plan Update, documenting the additional detailed analysis completed and the revised recommendations for abatement of CSOs. Please do not hesitate to contact us with any additional questions or comments.

Sincerely,

WOODARD & CURRAN, INC.

Megan McDevitt, PE
Senior Project Manager

Enclosure Combined Sewer Overflow Facilities Plan

cc: Brad Weeks, South Portland Water Resource Protection Director
Justin Gove, South Portland Engineer

COMBINED SEWER OVERFLOW FACILITIES PLAN

Updated
May 2022

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City of South Portland, ME

May 2022

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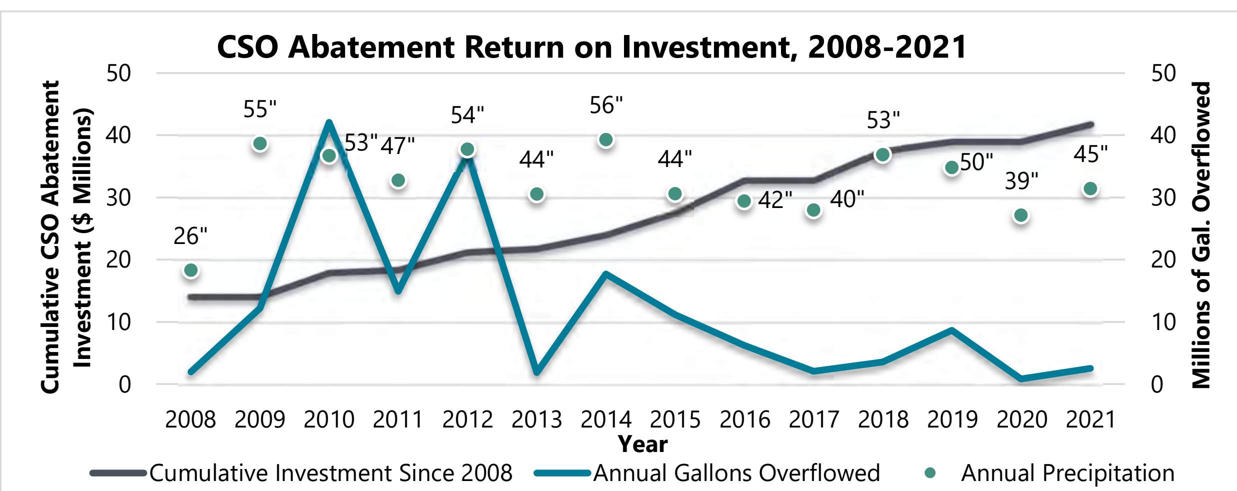
EXECUTIVE SUMMARY

The City of South Portland (City) has maintained a municipal wastewater collection system for over 100 years. Sanitary wastewater and stormwater were collected and conveyed within the same network and discharged untreated into the nearest water body. In 1975, the City constructed a Wastewater Treatment Facility (WWTF) to provide treatment to the combined sewer system prior to discharge. The City has been licensed under the Maine Department of Environmental Protection's (Maine DEP) Waste Discharge program since 1994. The City prepared a CSO Facilities Plan (Plan) in 1993 to identify methods to reduce combined sanitary and stormwater flows and has updated this Plan periodically over the intervening years. The City's latest Plan, developed in 2008 and revised in 2011, outlined a 12-year implementation schedule for addressing the City's then six remaining CSOs. The implementation plan targeted eliminating or reducing overflows generated from a 2-year, 24-hour storm event (design storm). The Plan update outlined in this document has been prepared to meet the conditions set forth in Special Condition K (4) of the City of South Portland's September 5, 2017 Maine Pollutant Discharge Elimination System (MEPDES) permit and Waste Discharge License which requires the City to submit an updated CSO Facilities Plan and implementation schedule by October 15, 2022.

Since 2011, the City has closed two additional CSOs, in accordance with its Plan. The existing combined sewer collection system has four remaining permitted CSO outfall locations: CSO #005 (Cash Corner), CSO #006 (Broadway/Evans), CSO #018 (Front Street) and CSO #024 (Elm Street). CSO #005, #006 and #024 are located on the western portion of the City in series, upstream of the Pearl Street Pump Station. CSO #18 is located on Front Street in the eastern portion of the collection system. South Portland's long-term objective is to close all CSO outfall locations except for CSO #024 and CSO #018. Maintenance of one emergency relief point in each region of the collection system is necessary to protect infrastructure and property from flooding.

Since 1994, the number of active permitted CSOs has been reduced from fifteen to four because of the separation projects and facility and operational improvements implemented. As a results of the CSO closures, the annual CSO volume has dropped from approximately 200 million gallons during 29 CSO events in 1994 to approximately 860,000 gallons during only three CSO event in 2020. Overall, the operational improvements and sewer separation projects implemented by the City over the past 27 years have resulted in greater than 97% reduction in the overall annual volume of overflow and an approximately 90% reduction in annual number of CSO events. CSO activity from 2008 to 2021, overlain with City investments and precipitation is summarized in the following figure.



The combined sewer collection system in the area contributing to the Pearl Street Pump Station and area contributing to CSO #018 were modeled using PCSWMM in 2019 and 2018, respectively. Consistent with the CSO mitigation efforts to date, the 2-year, 24-hour design storm was selected with an accompanying moderate groundwater condition to establish overflow volumes for present conditions. The table at right indicates the modeled CSO volumes at the remaining outfalls during the design storm. The low volumes computed are reflective of the progress made by the City during the last 27 years.

CSO Location	Overflow Volume (MG)
CSO #005	0[1]
CSO #006	0.99[1]
CSO #024	0[1]
CSO #018	0.30[2]

1 -Table 5-2: Comparison of CSO Volume for Revised Model with Previous Models for 2-Year Design Storm Calibration (Appendix A) – Prepared by AECOM 2021
2 – Table 6: System Overflow Values for Varying Storm Events while the Pump Operates at Maximum Capacity – Front Street Pump Station Evaluation prepared by AECOM 2018

Consistent with Maine DEP Chapter 570 Rules and the EPA's Nine Minimum Controls, we identified and evaluated seventeen alternatives with the objective of eliminating CSO volume at the four remaining CSO locations during the design storm and shifting overflows to less sensitive receiving waters during greater storm events. A range of control measures, including source reduction through inflow and infiltration reduction, increased conveyance capacity, inline storage, and offline storage were considered. Alternatives were evaluated using the existing conditions PCSWMM model and CSO volume abatement values were established for each alternative. Alternatives that did not yield substantial benefit or were otherwise determined not feasible for constructability reasons were eliminated, and the remaining alternatives were selected for conceptual design and cost estimating, hereafter referred to as recommended alternatives. In addition to the recommended alternatives, we identified several investigative actions which will serve to inform specific implementation decisions and evaluate the effectiveness of implemented alternatives.

The recommended alternatives and additional investigative actions have been compiled into an implementation plan. Based on results of this analysis, the recommended actions will reduce the CSO volume at the four remaining CSOs to zero during the 2-year, 24-hour design storm under moderate groundwater conditions; furthermore, recommended alternatives eliminate CSO volume at CSOs #005 and #006 during the 5-year, 24-hour design storm. The table below lays out the implementation plan.

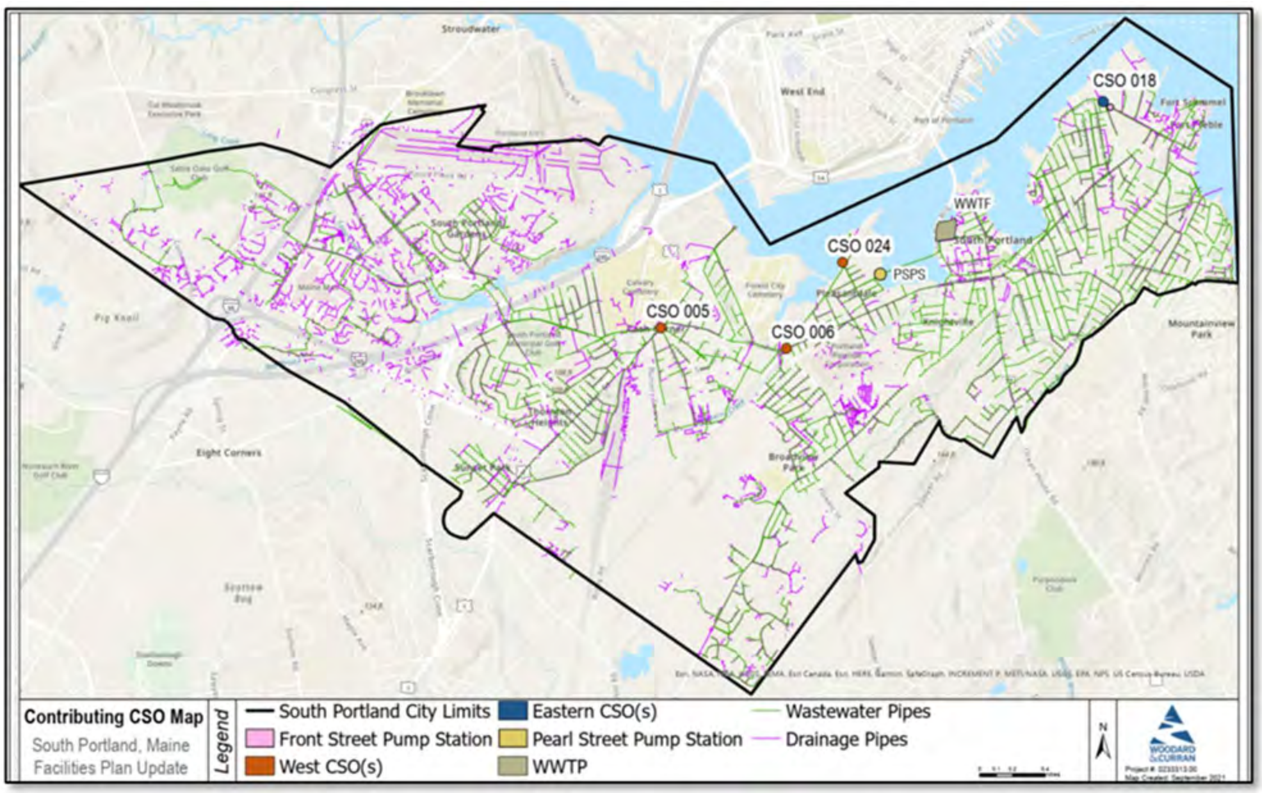
Implementation Plan	Expected Start	Expected Completion	Estimated Cost (with Escalation)
Meetinghouse Hill Separation – *Complete*	2021	2022	$2,800,000
Alternative 10 - Increase Pearl Street Pump Station Capacity	2023	2024	$15,900,000
Alternative 7 - Raise CSO #006 Weir	2023	2023	$53,000
Alternative 15 - Targeted Infiltration Study & Renewal Program	2022	2032	$2,500,000
Alternative 9 – Increase Conveyance Capacity from CSO #006 to Pearl St Pump Station	2027	2030	$14,900,000
Post-Implementation Verification (CSO #018)	2028	2028	$275,000
Post-Implementation Verification (CSO #005, #006 and #024)	2030	2030	$400,000

1. INTRODUCTION

1.1 Background

The City of South Portland (City) has maintained a municipal wastewater collection system for over 100 years. Sanitary wastewater and stormwater were collected and conveyed within the same network and discharged untreated into the nearest water body. With the passage of the Clean Water Act in the 1972, the City constructed a collection system throughout the City and a central wastewater treatment facility (WWTF) on Waterman Drive (see Figure 1-1 below).

Figure 1-1: South Portland Collection System Map



Due to the combined nature of the original collection system, many combined sewer overflow (CSO) discharge points remained active at that time to provide relief points when flows exceeded system capacity.

The City has been licensed under the Maine Department of Environmental Protection's (Maine DEP) Waste Discharge program since 1994. This license allows discharge of secondary treated sanitary waste waters and combined sanitary and stormwater to the Fore River. As part of this program, the City is obligated to reduce the volume of combined sewer overflow discharged. The City prepared a CSO Facilities Plan (Plan) in 1993 to identify methods to reduce combined sanitary and stormwater flows and has updated this Plan periodically over the intervening years. The City's latest Plan, developed in 2008 and revised in 2011, outlined a 12-year implementation schedule for addressing the City's then six remaining CSOs. The implementation plan targeted eliminating or reducing overflows generated from a 2-year, 24-hour storm event (design storm). Since 2008, the City has substantially completed the recommended abatement projects of the implementation plan, resulting in the elimination of two CSOs and significantly reducing annual discharge volumes from the others.

This Plan update has been prepared to meet the conditions set forth in Special Condition K (4) of the City of South Portland's September 5, 2017 Maine Pollutant Discharge Elimination System (MEPDES) permit and Waste Discharge License, which requires the City to submit an updated CSO Facilities Plan and implementation schedule by October 15, 2022.

1.2 Existing Collection System and Treatment Facility

1.2.1 Collection System

South Portland's combined sewer collection system consists of approximately 119 miles of pipe ranging in size from 4 to 48 inches in diameter, with the majority between 8 and 12 inches in diameter. Appendix A-1 shows a detailed map of the collection system. Construction of early (ca. 1910) portions of the system is dominated by vitrified clay (VC) pipe. More recent extension and infrastructure renewal projects consist mainly of polyvinyl chloride (PVC) and reinforced concrete pipe (RCP).

In addition to the gravity portions of the network, there are 41 pump stations (including private stations). Pump station capacity ranges from 50 gallons per minute (GPM) to 12,000 GPM. The collection system is divided into two topographically distinct geographic regions of the City which convey flow to the WWTF in parallel; the western side and eastern side. In general, the wastewater from the western side of the City is conveyed by gravity pipe and pump stations to the Pearl Street Pump Station (PSPS) where it is pumped approximately 2,300 feet through a 24-inch force main to the treatment plant. Wastewater from the eastern side of the City flows by gravity directly or through two major pump stations at West High Street and Front Street. Wastewater is conveyed by gravity from the force main terminus of these stations on Mussey Street to the WWTF.

The combined sewer collection system has four remaining permitted CSO outfall locations: CSO #005 (Cash Corner), CSO #006 (Broadway/Evans), CSO #018 (Front Street) and CSO #024 (Elm Street). CSO #005, #006 and #024 are located on the western portion of the City in series upstream of the Pearl Street Pump Station. CSO #18 is located on Front Street in the eastern portion of the collection system. South Portland's long-term objective is to close all CSO outfall locations except for CSO #024 and CSO #018. Maintenance of one emergency relief point in each region of the collection system is necessary to protect infrastructure and property from flooding.

1.2.2 Treatment System

The South Portland WWTF was upgraded in 1994 to provide secondary treatment of up to 22.9 million gallons per day (MGD) of wastewater and to provide primary treatment with disinfection of an additional 33.1 MGD of wastewater through a CSO-related bypass treatment system (total of 56 MGD) when the Fore River water surface is below the base flood elevation (El 10 NGVD).

Wastewater from the eastern half of South Portland enters the Main Pump Station at the WWTF by gravity. The pump station is equipped with a coarse manual bar rack prior to the wet wells. The pumps discharge wastewater to a distribution box at the head end of aerated grit chambers at the WWTF site. Wastewater from the western half of South Portland enters the WWTF via force main from the Pearl Street Pump Station, which is equipped with a mechanical bar screen and aerated grit chamber. Screened wastewater is pumped from the Pearl Street Pump Station to a location just downstream of the aerated grit chambers at the WWTF site. The combined WWTF influent flows by gravity through a Parshall flume for flow measurement and to a mechanical bar screen for fine screening. After primary treatment, flows proceed by gravity to the aeration basin flow splitter for distribution to three aeration basins.

Secondary treatment is provided by an activated sludge process. The activated sludge process can be operated in conventional, extended, plug flow, contact stabilization, complete mix or step feed modes. The aeration basin effluent (mixed liquor) flows by gravity to the aeration basin outlet box and to the secondary clarifier flow splitter box for distribution to three, ninety-foot diameter clarifiers for settling. Secondary clarifier effluent flows by gravity to the chlorination chamber for disinfection with sodium hypochlorite. Flows proceed by gravity through the chlorine contact tank to the dechlorination chamber. Chlorinated effluent is mixed with sodium bisulfite to minimize chlorine residual prior to discharge to the Fore River through a 54" fiberglass reinforced plastic (FRP) gravity outfall pipe.

Overflows to the CSO-related bypass treatment system occur under two scenarios. The first scenario is when flow into the Main Pump Station exceeds the capacity of the pumps (15.6 MGD), the influent wet well will surcharge over a fixed weir into the pump station's overflow wet well. The second scenario in which an overflow may occur is under the control of a flow limiting switch. When incoming flows to the treatment facility, as measured at the influent Parshall flume, exceed the setpoint of the flow limiting switch (currently set at 22.9 MGD), pumps at the Main Pump Station are ramped down. This similarly causes the influent wet well to surcharge into the overflow wet well and allows Pearl Street Pump Station flows to be maximized. The intent of this measure is to avert an untreated bypass upstream of the Pearl Street Pump Station and instead "force" an overflow at the treatment facility where the overflow can receive primary treatment and disinfection before release to the Fore River.

Under either of the two overflow scenarios, dedicated overflow pumps direct flow to the overflow channel adjacent to the Main Pump Station. This channel contains a Parshall flume for measurement of bypass flows. Flows then travel by gravity to the overflow clarifier flow splitter, where flows are directed to one or more of three, 60-foot diameter overflow clarifiers. At this splitter box, the residual chlorine is measured and sodium hypochlorite is added to maintain a preset residual. In the clarifiers, primary treatment occurs through settling, then flows exit the clarifiers and drain by gravity to the overflow dechlorination chamber attached to the side of the chlorine contact tank. Treated flows are mixed with sodium bisulfite to eliminate residual chlorine prior to release into the Fore River. Discharge to the Fore River is through the same 54" outfall pipe used to convey secondary treated flows.

1.3 Regulatory Requirements

1.3.1 MEPDES Permit Requirements

The discharge license for the South Portland WWTF (WDL #W001370-5M-K-R/MEPDES Permit #ME0100633) was renewed on September 5, 2017 for a five-year period. A copy of the final MEPDES permit and a Maine WDL revision approved by the Maine DEP was issued on March 9, 2018, Filed March 12, 2018. This permit authorizes the City to discharge:

- An average monthly discharge of up to 9.3 MGD of secondary treated sanitary wastewater.

- An unspecified quantity of excess combined sanitary and storm water receiving primary treatment only.
- An unspecified quantity of excess combined sanitary and storm water during wet weather events from six combined sewer overflow outfalls from the locations outlined in Section 1.4.1.

1.3.2 EPA and Maine DEP CSO Regulations

Maine DEP Chapter 570 - Combined Sewer Overflow Abatement guidelines outlines the basis by which a discharge from a combined overflow point within a sewerage system can be permitted. Per Maine DEP Chapter 570 guidelines, the discharge must meet the following conditions:

- *Discharge in excess of design capacity*: The discharge consists of wastewater in excess of design capacity of the sewerage system or treatment facilities;
- *Discharge not due to mechanical failure*: The discharge is not the result of mechanical failure, improper design or inadequate operation or maintenance; and
- *CSO Master Plan*: The licensee is actively developing or implementing a CSO Master Plan (Facilities Plan) in accordance with the Maine DEP Chapter 570 guidelines, and as approved by the Department; or the licensee has implemented the CSO Master Plan and a discharge occurs that is caused by conditions exceeding those upon which the Plan is based.

The September 5, 2017 discharge license and March 9, 2018 revision for the South Portland WWTF requires the City to implement and follow Nine Minimum Controls (NMC) as approved by the EPA. The NMC are discussed in Section 4 of this Plan.

1.4 CSO Facilities Plan Achievements to Date

Since entering the Waste Discharge program in 1994, the City has completed more than 50 projects reducing the volume of wastewater discharged from the City's CSOs. According to records compiled by the City and Maine DEP, the annual CSO volume has dropped from approximately 200 million gallons in 1994 over the course of 29 events to approximately 860,000 gallons in 2020, which occurred during only three CSO events. Between 1994 and 2020, the City has invested over $41.8 million to perform CSO abatement projects. A summary of those projects is shown in Table 1-1 below.

Table 1-1: CSO Facilities Improvement Projects

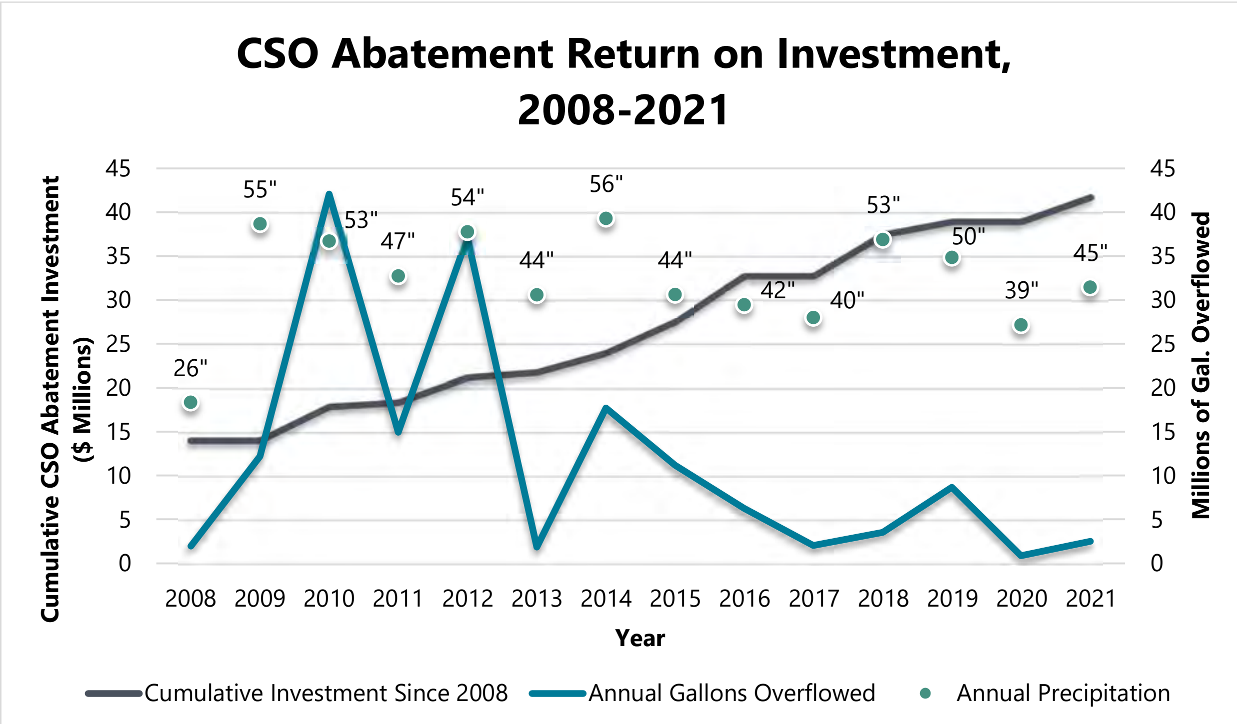
Year	Project	Cost
Conveyance & Wet Weather Treatment		
1993	Trunk Line "A" Cleaning	$160,000
	Treatment Plant Upgrade (CSO-Related Bypass)	$1,400,000[1]
1995	Front Street Pump Station Upgrade Willard Beach Pump Station Upgrade West High Street Pump Station Upgrade Main Street Pump Station Upgrade Pearl Street Pump Station Upgrade	$1,300,000
2001	Pearl Street Pump Station (Screening Improvements)	$222,000
2002	Willard Beach Pump Station Upgrade (Generator)	$60,000
2004	Pearl Street Pump Station Upgrade (Generator)	$59,939
2005	Main Street Pump Station Upgrade (Generator)	$37,408
2007	CSO Facilities Plan Update	$212,379
2008	Front Street and West High Street Pump Stations Upgrade (Emergency generators to operate high flow pump during power outages)	$379,000
2009 - 2011	Long Creek Phase 1 (Pump Station Capacity Upgrade)	$3,850,000
2011	West High Phase 1 (SSES Study)	$109,000
2012	WWTP CSO Clarifier Upgrade	$978,000
2018	Ottawa Road I&I Removal Project Phase 1	$571,000
2019	Ottawa Road I&I Removal Project Phase 2	$400,545
2019	Front Street Pump Station Upgrade	$68,200
2019	Greenbelt Trunkline Sewer Upgrade	$1,471,500
Sewer Separation Projects		
1986	Brooklyn Heights	$333,000
1988-1990	Trunk Line "B"	$1,300,000
1989	Pickett Street	$200,000
1989-1990	McKinley Street	$29,000
	Grove & Osbourne	$16,000
	Upper & Lower Cleveland Circle	$10,000
	Adelbert Street	$40,000
	Main and NY	$4,000
	Pierce & Sawyer	$4,000
	Nelson Street	$4,000
1993	Lincoln Street (Stormwater Treatment Tank)	$80,000
1994	Cottage Road	$60,000

[1] Total Treatment Plant Upgrade project cost of $9.2 million

Year	Project	Cost
	Hoyt and Kelsey	$35,000
	Old Joe's Pond	$75,000
1996	School Street	$102,000
1997	Ferry Village I	$358,000
	Red Bank I	$717,000
1998	Ferry Village II	$699,000
	Red Bank II	$390,000
	Cottage Road/Davis Street	$125,000
1999	Willard Beach	$450,000
	Cash Corner	$615,000
	City Hall	$30,000
2000	Broadway/Mussey	$306,000
	Pleasantdale Phase I	$151,000
2003	Cash Park	$408,000
	Virginia Avenue Stormwater Drainage	$5,000
2004	North Marriner Street	$45,531
2005	Adelbert, Sylvan and Stillman	$296,225
2006	Pleasantdale Project	$2,088,641
	Lincoln Street Extension	$11,356
2007	Front Street	$31,121
2008	Margaret Street	$15,093
2011	Knightville Phase I	$375,000
2012	Knightville Phase II Project	$2,800,000
2013	Mussey/Sprague	$240,000
2014	Thornton Heights Phase 1	$2,190,000
2015	Thornton Heights Phase 2	$3,575,000
2016	Thornton Heights Phase 3	$5,204,000
2016	Sandy Hill Project	$22,300
2018	Pleasantdale Phase II	$4,139,400
2021	Meetinghouse Hill Phase 1	$2,800,000
Other Projects		
Manhole Sealing Program		$15,000
Sump Pump/Roof Leader Program		$160,000
	TOTAL	**$41.8 million**

Since 1994, the number of active permitted CSOs has been reduced from fifteen to four because of the separation projects and facility and operational improvements that have been completed. Overall, the operational improvements and sewer separation projects implemented by the City over the past 27 years have resulted in greater than 97% reduction in the overall annual volume of overflow and an approximately 90% reduction in annual number of CSO events. CSO activity from 2008 to 2021 is summarized in the following figure.

Figure 1-2: CSO Abatement Activity 2008-2021



1.5 Active CSO Facilities Improvement Projects

In 2021, the City of South Portland began the construction of the Meetinghouse Hill Phase 1 drainage improvements project in 2021. The project includes storm drainage improvements to provide additional capacity for future combined sewer separation. The first phase of the project includes storm drainage improvements in Broadway, Highland Avenue, Cottage Road and O'Neill Street. The City of South Portland's former Public Works site on O'Neill Street is planned for residential redevelopment beginning in 2022. The redevelopment of the site is expected to separate runoff from approximately 6.7 acres, redirecting runoff from the combined sewer system in Walnut Street and Cottage Road to the separated storm drain system in Cottage Road.

The Phase 1 improvements also provide capacity for the potential future separation of the west Meetinghouse Hill neighborhood. This future separation encompasses an approximately 32-acre watershed currently drained by the combined sewers in Jordan Avenue, Providence Avenue, South Richland Avenue, Boothby Avenue and a portion of Pitt Street.

2. RECEIVING WATERS OF CSO OVERFLOWS

2.1 Water Quality Standards

2.1.1 Fresh Surface Waters Standards

Maine law, 38 M.R.S.A §465 defines four standards for the classification of fresh waters. Fresh water classifications range from Class AA, the highest classification, to Class C waters, which are the fourth and lowest classification of fresh waters. All CSO discharges to freshwater in South Portland are to Class C waters. Class C waters must meet the following requirements:

- Class C waters must be suitable for uses including drinking water supply after treatment, fishing, agriculture, recreation in and on the water, navigation and as a habitat for fish and other aquatic life.
- The dissolved oxygen content of Class C water may not be less than 5 parts per million or 60% of saturation, whichever is higher.
    - The 30-day average dissolved oxygen criterion of a Class C water is 6.5 parts per million using a temperature of 22 degrees centigrade or the ambient temperature of the water body, whichever is less, if:
        - A license or water quality certificate other than a general permit was issued prior to March 16, 2004 for the Class C water and was not based on a 6.5 parts per million 30-day average dissolved oxygen criterion; or
        - A discharge or a hydropower project was in existence on March 16, 2005 and required but did not have a license or water quality certificate other than a general permit for the Class C water.
    - In Class C waters not governed by the above paragraphs, dissolved oxygen may not be less than 6.5 parts per million as a 30-day average based upon a temperature of 24 degrees centigrade or the ambient temperature of the water body, whichever is less.
- Between April 15th and October 31st, the number of Escherichia coli bacteria in Class C waters may not exceed a geometric mean of 100 CFU per 100 milliliters over a 90-day interval or 236 CFU per 100 milliliters in more than 10% of the samples in any 90-day interval.
- Discharges to Class C waters may cause some changes to aquatic life, except that the receiving waters must be of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.

2.1.2 Estuarine and Marine Waters Standards

Maine law, 38 M.R.S.A §465-B defines three standards for the classification of estuarine and marine waters. Estuarine and marine water classifications range from Class SA, the highest classification, to Class SC waters, which are the third and lowest classification of marine and estuarine waters. All CSO discharges to estuarine or marine waters in South Portland are to Class SC waters. Class SC waters must meet the following requirements:

- Class SC waters must be suitable for uses including recreation in and on the water, fishing, aquaculture, propagation and restricted harvesting of shellfish, industrial process and cooling water supply, hydroelectric power generation, navigation and as a habitat for fish and other estuarine and marine life.
- The dissolved oxygen content of Class SC waters may not be less than 70% of saturation.
- Between April 15th and October 31st, the number of enterococcus bacteria in these waters may not exceed a geometric mean of 14 CFU per 100 milliliters in any 90-day interval or 94 CFU per 100 milliliters in more than 10% of the samples in any 90-day interval. The number of total coliform bacteria or other specified indicator organisms in samples representative of the waters in restricted shellfish harvesting areas may not exceed the criteria recommended under the National Shellfish Sanitation Program, United States Food and Drug Administration.
- Discharges to Class SC waters may cause some changes to estuarine and marine life provided that the receiving waters are of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community.

2.1.3 Integrated Water Quality Report

The Maine DEP prepares a biennial report assessing the quality of waters throughout the state to fulfill requirements of the Clean Water Act. The most recently approved list of waters and their classifications is the 2016 Integrated Water Quality Report. The Integrated Report classifies waters according to the following categories:

Table 2-1: Integrated Report Water Classification Categories

Listing Category	Category Summary
1	Fully Attaining All Designated Uses
2	Attaining Some Designated Uses - Insufficient Information for Other Uses
3	Insufficient Data or Information to Determine if Designated Uses are Attained (One or More Uses may be Impaired)
4A	Impaired Use, Total Maximum Daily Limit (TMDL) Completed
4B	Impaired by Pollutants - Pollution Control Requirements Reasonably Expected to Result in Attainment
4C	Impairment not Caused by a Pollutant
5A-5C	Impaired, TMDL Required
5D	Impaired by Legacy Pollutants

2.2 CSO Outfall Receiving Waters

Table 2-2 summarizes the receiving waters and water body classification of the four active permitted CSO outfall locations within the City of South Portland.

Table 2-2: Summary of Active Permitted CSO Outfall Locations

CSO Number and Name	Outfall Location	Receiving Water and Class	Integrated Report Category
#005 Cash Corner	Main Street/Cash Corner	Calvary Cemetery Ponds, Class C	NA
#006 Broadway/Evans	Broadway & Evans	Barberry Creek/Fore River, Class C/SC	4A & 5A
#018 Front Street	Front Street Pump Station	Portland Harbor, Class SC	5A
#024 Elm Street	Turners Island	Fore River, Class SC	5A

2.2.1 Calvary Cemetery Ponds

The Cash Corner CSO #005 discharges to the Calvary Cemetery Ponds, located north of Cash Corner and Main Street. While the ponds are designated as a Class C waterbody, the ponds are man-made and the Maine DEP has no current plans to conduct a TMDL on these surface water bodies (as of the 2016 Integrated Report).

2.2.2 Barberry Creek

The Broadway and Evans CSO #006 discharges to Barberry Creek. Barberry Creek is listed as a Category 4-A and is impaired for biological and habitat criteria (benthic-macroinvertebrate bioassessments and habitat assessments). Barberry Creek is also listed as an Urban Impaired Street (UIS) in Maine DEP Chapter 502.

Barberry Creek has an approved impervious cover TMDL, with a target impervious cover of 12% in the watershed as a surrogate for pollutant-specific concentration levels, although Maine DEP uses pollutant-specific water quality criteria (SWQC) to assess both acute and chronic impacts of toxic contaminants. The 2006 TMDL assumed that CSO #006 would be removed by December 31, 2006 under the City of South Portland's MEPDES discharge permit. Therefore, to be consistent with the conclusions of the TMDL, it would be important to abate or eliminate the CSO discharge into Barberry Creek from CSO #006 if practicable. Control measures outlined in this Facilities Plan will target elimination of discharges at CSO #006 during the design event through source reduction, storage, conveyance improvements, and/or shifting discharge downstream to CSO #024.

2.2.3 Fore River

The Front Street CSO #018 and the Elm Street CSO #024 both discharge to the Fore River. A 768-acre segment of the Fore River is listed as a Category 5-A estuarine water with impaired marine life use support. The Integrated Report lists municipal discharges, CSOs, stormwater, hazardous waste sites and nonpoint sources as sources of pollution.

3. CSO ASSESSMENT AND MONITORING

3.1 CSO Flow Monitoring

The City of South Portland monitors CSO discharge locations using water level and redundant ultrasonic meters and pressure transducers, calculating flow using weir equations. Volume for each event is recorded and reported to the Maine DEP on an annual basis in accordance with the discharge permit.

CSO activity from 2008 (the date of the previous Facility Plan Update) to 2021 is summarized in the following table and figures. Table 3-1 below compiles CSO activity data across all active CSO outfalls.

Table 3-1: Summarized CSO Activity 2008-2021

Year	Total Overflow in MG (# of Events)	Annual Precip. (in.)	Overflow Volume in MG (Number of Events)			
			CSO #005	CSO #006	CSO #018	CSO #024
2008	1.96 (4)	26.25	0.01 (2)	0.01 (2)	0.00 (2)	0.25 (4)
2009	12.2 (10)	55.33	6.66 (9)	3.30 (7)	1.86 (4)	0.00
2010	42.1 (12)	52.51	14.68 (11)	10.97 (10)	3.28 (6)	12.53 (10)
2011	14.9 (13)	46.85	2.67 (3)	2.14 (3)	1.28 (2)	8.59 (11)
2012	37.1 (11)	54.00	10.78 (10)	8.00 (9)	2.16 (5)	16.19 (11)
2013	1.9 (7)	43.74	0.75 (4)	0.29 (4)	0.03 (3)	0.79 (6)
2014	17.7 (9)	56.20	1.22 (4)	1.65 (4)	2.88 (4)	11.90 (9)
2015	11.1 (2)	43.82	6.60 (2)	0.00	1.18 (2)	3.38 (2)
2016	6.2 (3)	42.12	0.91 (2)	3.79 (3)	0.34 (2)	1.21 (2)
2017	2.0 (2)	40.06	0.00	1.31 (1)	0.00	0.73 (1)
2018	3.5 (4)	52.78	0.38 (2)	0.08 (2)	0.00	3.08 (4)
2019	8.7 (3)	49.83	1.94 (2)	0.78 (2)	1.45 (2)	4.49 (3)
2020	0.86 (3)	38.85	0.03 (2)	0.01 (1)	0.25 (2)	0.57 (3)
2021	2.51 (2)	44.87	0.39 (1)	0.03 (1)	0.00	2.09 (2)

Figures 3-1 through 3-4 display the number of CSO events and volume (MG) data at each active CSO location compared to annual precipitation in inches.

Figure 3-1: CSO #005 Overflow and Volume Data Summary 2008-2021

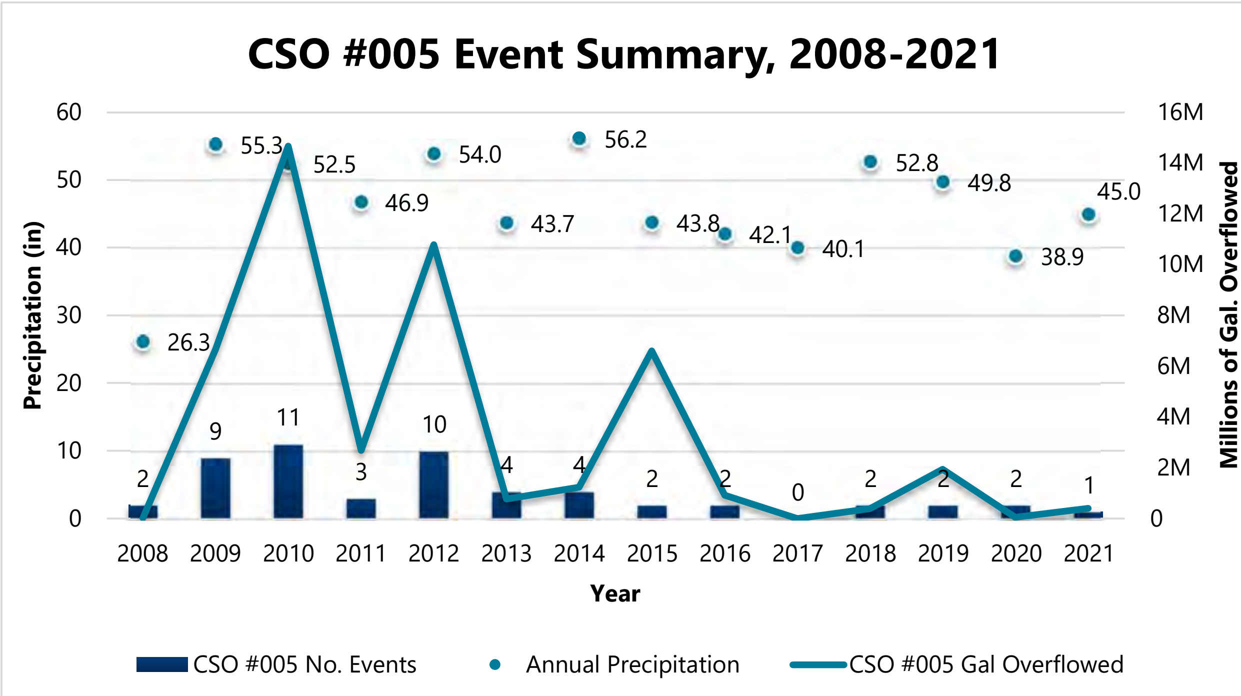


Figure 3-2: CSO #006 Overflow and Volume Data Summary 2008-2021

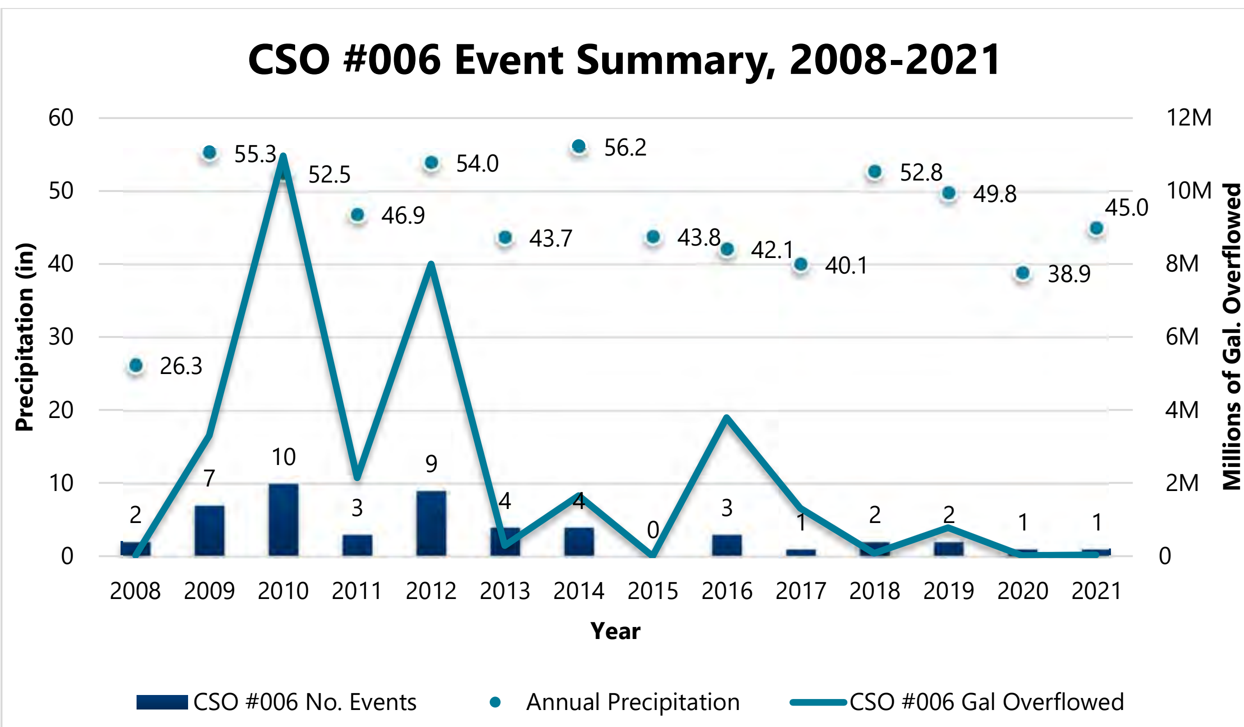


Figure 3-3: CSO #018 Overflow and Volume Data Summary 2008-2021

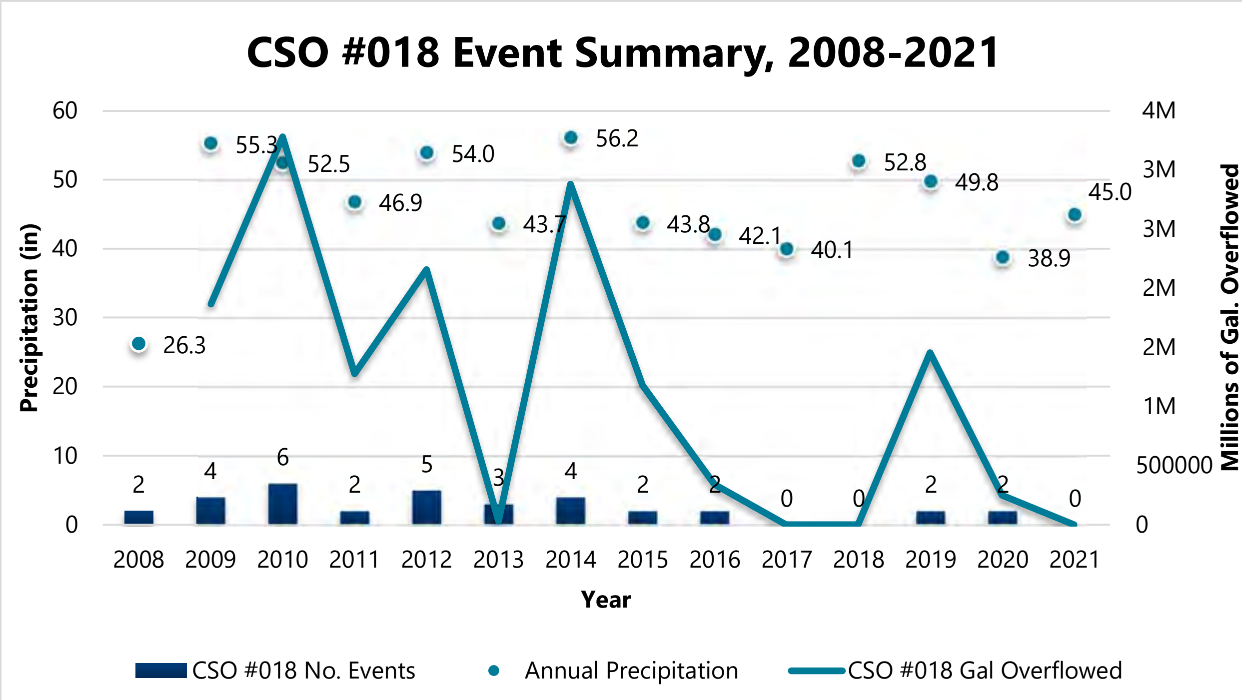
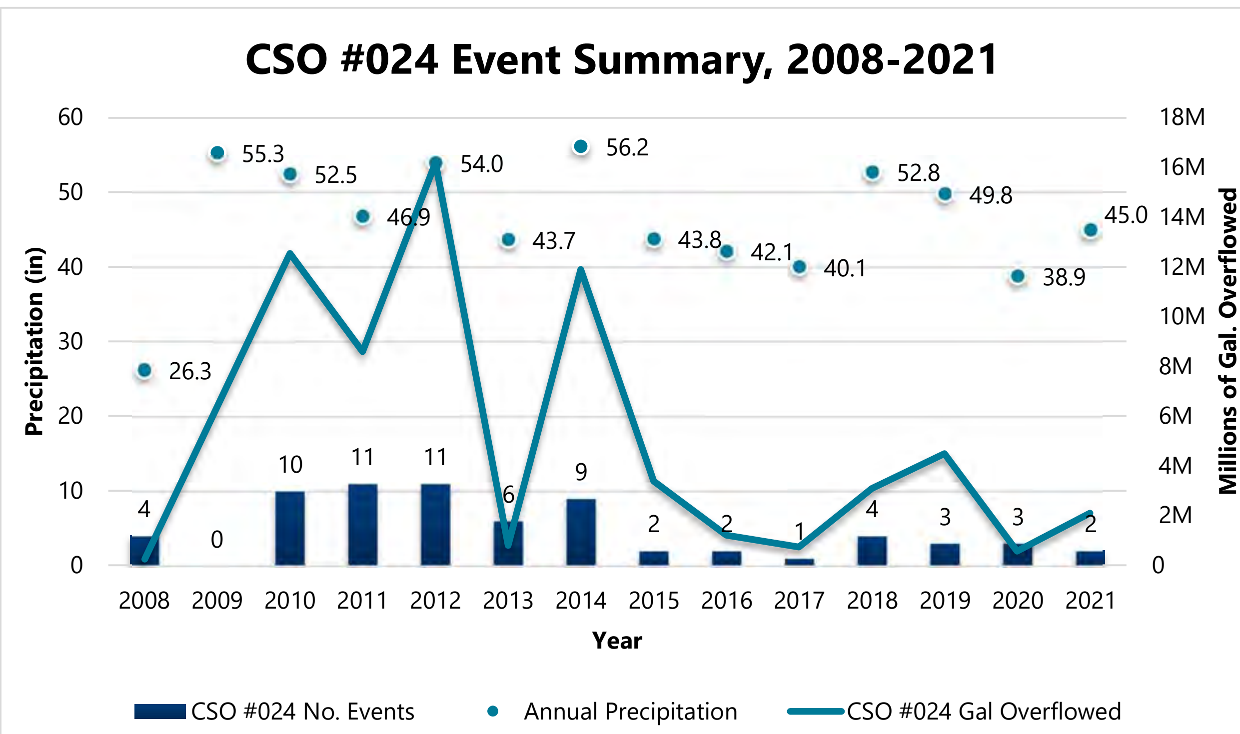


Figure 3-4: CSO #024 Overflow and Volume Data Summary 2008-2021



3.2 Sewer System Flow Metering

Collection system flows have been metered periodically since the previous Facilities Plan to evaluate system conditions and observe efficiency of CSO abatement projects. Permanent flow meters are maintained at pump stations and CSO regulator. Additional temporary flow meters were installed at strategic locations during periods in the spring of 2018 and 2020 to collect flow data used for updating and calibrating the sewer system model. Metering data used for the most recent model update is included in Appendix B.

3.3 Sewer System Modeling

The combined sewer collection system in the area contributing to the Pearl Street Pump Station and CSO #018 contributing area was modeled using PCSWMM. Consistent with the CSO mitigation efforts to date, the 2-year, 24-hour design storm was selected. The east and west sides of the collection system were modeled separately. Subsections 3.3.1 and 3.3.2 summarize the methodology and findings of those efforts. Table 3-2 below summarizes the overflow volumes calculated.

Table 3-2: Modeled CSO Volumes During Design Storm

CSO Location	Overflow Volume (MG)
#005	**0[1]**
#006	**0.99[1]**
#024	**0[1]**
#018	**0.30[2]**

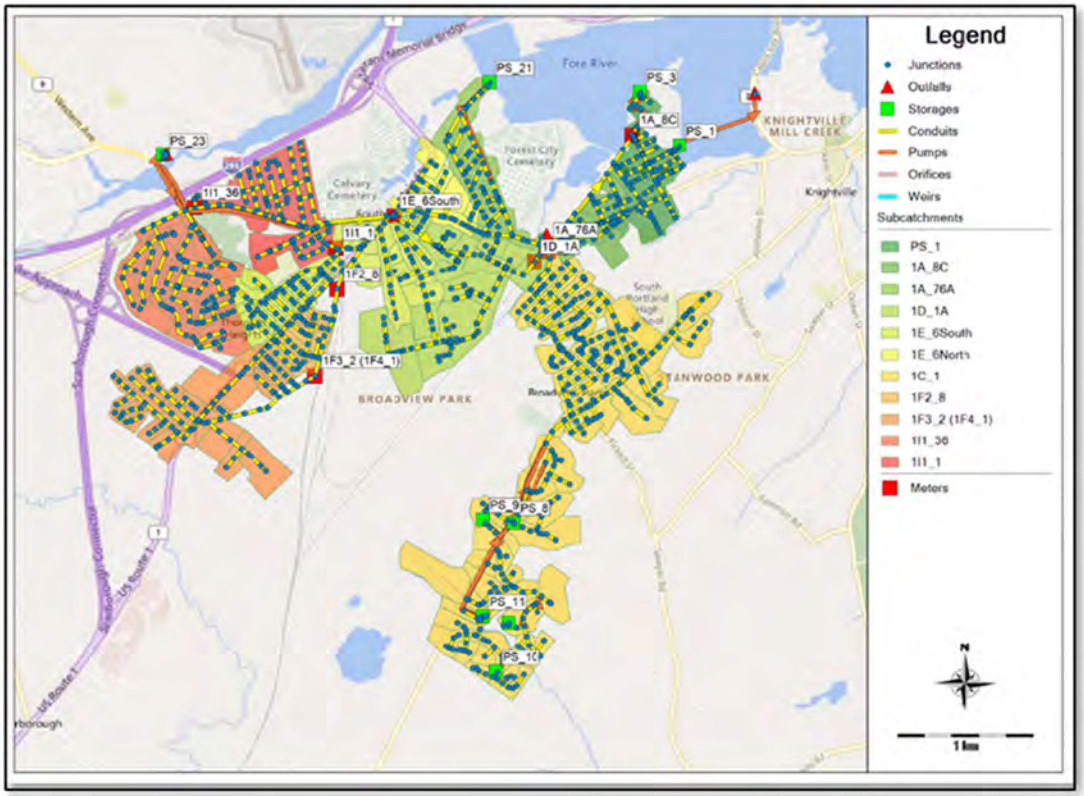
1. Table 5-2: Comparison of CSO Volume for Revised Model with Previous Models for 2-Year Design Storm Calibration (Appendix A) – Prepared by AECOM 2021
2. Table 6: System Overflow Values for Varying Storm Events while the Pump Operates at Maximum Capacity – Front Street Pump Station Evaluation prepared by AECOM 2018

Modeling has focused on the 2-year, 24-hour design storm, consistent with previous planning efforts. At the request of the Maine DEP, options for eliminating CSO volumes at CSO #005 and CSO #006 during greater storm events were also evaluated. The results of that evaluation are documented in Section 6.

3.3.1 West Side of Collection System

Hydraulic modeling conducted in 2019 using a skeleton model (a model representing key collection system components, CSO outfalls, main interceptors, and the Pearl Street Pump Station, as well as all conduits with available flow meter data) indicated there were significant groundwater inflow into the Pearl Street system. Additional flow data and survey was collected in 2020 to further refine the hydraulic model and evaluate potential alternatives. The 2019 model was combined with the 2012 model and then was updated to include the new survey data. This is referred to as the 2020 model and is shown in Figure 3-5. This model includes the sewers, catchments, CSO regulators, and pump stations that are tributary to the Pearl Street Pump Station. Additional detail of the modeling update is presented in Appendix B.

Figure 3-5: 2020 SWMM Model



The 2012 model utilized the RTK methodology for simulating wet weather flows. The RTK method represents three distinct stages of the wet weather event: direct inflow from the catchment, delayed inflow from damaged connections or leaks, and groundwater infiltration through cracks and defects in the pipe network. A trio of unit hydrographs are calibrated to match observed flow data using three parameters: percentage of runoff (R), time (T), and the recession time for the event (K). This methodology was retained for the areas upstream of pump station PS23. These were not adjusted as part of the 2020 update because the flow monitoring data were collected downstream from these areas and therefore there was no basis to adjust the model in these areas. The areas downstream of the pump stations utilized the SWMM runoff to simulate the fast response and the non-linear SWMM groundwater routine to simulate the slow response. This downstream portion of the model was calibrated using 12 flow gages and rainfall collected from March 25 to April 28, 2020. This period included seven storms ranging from depths of 0.11 inches to 1.64 inches. The flow metering data indicated the wet weather response to rainfall throughout the precipitation event was predominately slow acting groundwater infiltration with some meters showing some fast response that is characteristic of impervious surfaces. During the wet weather calibration process, the percentage of impervious areas and catchment width were adjusted to better correlate the model to the fast response component of the flow metering data, while the groundwater module was used calibrate the groundwater response. An analysis of the flow components at the Pearl Street Pump Station for the calibration period indicates that groundwater represented 17 percent of the total dry weather flow reaching the pump station and 80 percent of the wet weather flow by volume.

The model was applied to estimate CSO volume during a 2-year, 24-hour storm for a medium groundwater condition. A medium groundwater condition was selected based on the range of groundwater levels observed during metering and consistency with observed CSO volumes during recent years. The results indicate that 0.99 MG of CSO would occur at CSO #006 and no overflows at CSO #005 and #024, which is consistent with results from 2019 modeling. Based on the modeled overflow event, the 0.99 million gallons of overflow at CSO #006 is approximately 60% groundwater induced and approximately 40% rapid inflow induced. The maximum flow into the CSO #006 regulator is approximately 18.7 MGD, and the maximum flow of much of the downstream conveyance system is approximately 13.5 MGD.

The updated model is considered appropriate for evaluating improvements to the collection system, which are described elsewhere in this report.

3.3.2 East Side of Collection System

A skeleton model of the Front Street Pump Station system was created and calibrated using available flow meter data. The objective of the modeling was to evaluate the impact of various alternatives on the overflow at CSO #018. The model was calibrated using rainfall and pump station flow and level data for March 31-June 30, 2018. This period included five storms over 0.5 inches, with the largest being 1.84 inches. The flow metering data indicated a significant groundwater response, and therefore the groundwater module was used to simulate the delayed groundwater inflow. Figure 3-6 shows the model schematic.

Figure 3-6: Front Street SWMM Model Schematic

This model was used to determine the overflow volume during the design storm. Assuming the Front Street Pump Station is running at full capacity of 6,260 gpm, analysis indicates that an overflow of 0.30 MG will occur during the 2-year, 24-hour storm. Screening of control measures is included in Section 5.

4. SCREENING AND PRIORITIZATION

Maine DEP Chapter 570 establishes guidelines for prioritization of CSO outfalls and abatement measures. Minimum priorities for abatement are listed below with applicability to the City of South Portland CSO Facilities.

1. Discharges that occur during dry weather periods – there are no outfalls that discharge during dry weather periods.
2. Discharges that may impact public drinking water intakes – there are no discharges that impact public drinking water intakes.
3. Discharges that may impair water contact recreational uses or create public health concerns in the receiving waters – one discharge impacts water contact recreational uses or create public health concerns in the receiving waters.
4. Discharges that discharge into areas determined to have redeemable shellfish resources or important fish or wildlife habitat – CSOs within the system discharge to shellfish resources and important fish and wildlife habitat.
5. Discharges that contain industrial or medical wastes – there are no discharges containing industrial or medical wastes.
6. Discharges that function during the months of June through September – CSOs within the system discharge between June and September with sufficient rainfall.
7. Discharges that cause localized nuisance conditions – CSOs may cause localized nuisance conditions

Elimination of discharge to sensitive receiving waters is a primary Maine DEP directive, as conveyed during meetings with Maine DEP staff. Elimination of discharge to CSO #005 and CSO #006, which discharge to small, sensitive receiving waters, is a high priority.

In addition to the Maine DEP Chapter 570, the EPA requires that CSO Facilities Plan implement the best available technology economically achievable (BAT) or best conventional pollutant control technology (BCT). The EPA base expectation includes the Nine Minimum Controls (NMC) for CSO control, which include:

1. Proper operation and regular maintenance programs for the sewer system and CSO outfalls
2. Maximum use of the collection system for storage
3. Review and modification of pretreatment requirements to ensure that CSO impacts are minimized
4. Maximization of flow to the POTW for treatment
5. Elimination of CSOs during dry weather
6. Control of solid and floatable materials in CSOs
7. Pollution prevention programs to reduce contaminants in CSOs
8. Public notification to ensure the public receives adequate notification of CSO occurrences and CSO impacts
9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

The following subsections address the minimum control alternatives and applicability to remaining CSO discharges, prioritizing the remaining outfalls and screening control measures.

4.1 Prioritization

Maine DEP CSO abatement guidance lists "relocation of discharge to less sensitive receiving waters" as the final control measure. Maintaining functional relief points in the system will be necessary as long as wet-weather events cause flows exceeding the conveyance and treatment capacity of the system. In light of this, CSO outfall locations have been prioritized for development of alternatives based on the volume of discharge and the sensitivity of the receiving water. Where receiving water classifications are similar, mixing and dilution potential have been considered. Table 4-1 below ranks active permitted CSOs in order of priority for abatement.

Table 4-1: CSO Prioritization

Priority Ranking for Control Measures	CSO Outfall	Receiving Water (Classification; Category)	Design Storm Overflow Volume (MG)	Priority Ranking Considerations
1	**CSO #006**	Barberry Creek (Class C/SC; 4A)	0.99	Highest priority due to highest discharge volume related to stream flow; degraded stream classification; and proximity to sensitive ecological receptors (shellfish)
2	**CSO #018**	Fore River (Class SC; 5A)	0.30	High priority due to discharge volume and proximity to sensitive ecological receptors (shellfish), and recreational uses. Due to hydraulics of collection system, likely to remain online as east side extreme event relief point.
3	**CSO #005**	Calvary Cemetery Ponds (Class C; NA)	0	Moderate priority due to low discharge volume; high priority for future closure due to low stream flow and degraded stream classification
4	**CSO #024**	Fore River (Class SC; 5A)	0	Moderate priority due to low discharge volume and high dilution factor. Due to hydraulics of collection system, likely to remain online as west side extreme event relief point.

Due to the relative discharge volume and sensitivity of the receiving water, CSO abatement at CSO #006 is the highest priority for South Portland. The dynamic hydraulic relationship of CSO #005, #006, and #024 dictates that mitigation measures should be targeted at reducing the total volume of all three discharges as part of one system. Overflows result from a combination of surface water inflow, groundwater infiltration and conveyance capacity limitations. Control measures must address one or all of these areas, and priority should be given to mitigation measures that shift any remaining discharge locations to less sensitive receiving waters; in this case, CSO #024. Lastly, priority should be given to measures that may improve the upstream performance through source reduction or capacity increases such that South Portland may consider closure of CSO #005 and CSO #006 in future phases.

Abatement measures targeting CSO #018 are also high priority. Historically, downstream conveyance system capacity limitations contribute to the CSO events in this location, requiring that pumps run at less than full capacity to prevent SSO events downstream. Recent separation and conveyance upgrade projects have mitigated this situation. Previous modeling indicated that Front Street pump station capacity, even at 100%, is not sufficient to match simulated inflows; however, system performance during recent storm events show that recent projects have been effective, resulting in no overflows during a 25-year return period event.

4.2 Control Measure Screening

Maine DEP Chapter 570 guidelines prescribes evaluation of a range of alternative control measures. Alternative control measures must include:

1. Pollution prevention practices to reduce, control, or eliminate pollutants at their source and prior to entry into the sewerage system;
2. Removing sources of uncontaminated water introduced into the sewerage system from private and public sources;
3. Maximizing the existing sewerage system for storage, transport and treatment of wastewater;
4. Off-line storage or retention of excess flow for addition to the sewerage system as its capacity allows;
5. Sewer separation to remove stormwater from sanitary wastewater;
6. Full elimination of CSOs;
7. Treatment of CSOs; and
8. Discharge point relocation to less sensitive receiving waters.

In addition to these control alternatives, the City of South Portland also prioritizes the renewal of aging infrastructure in evaluating potential projects. Much of the primary conveyance pipe on the west side of the collection system was constructed in the early 20th century and may be nearing the end of its service life. The Pearl Street Pump Station and force main system is also at the end of its service life. Portions of the Front Street Pump Station contributing area on the east side of the collection system were installed in the late 19th and early 20th century and are at the end of their service life.

Tables 4-2 through 4-5 apply feasibility criteria to CSO mitigation control measures at each active permitted CSO outfall location. Control measures include I/I reduction and collection system rehabilitation, separation, collection system renewal, conveyance capacity improvement (gravity and pumping), satellite treatment, and storage (inline and offline). For this master planning effort, feasible alternatives are defined as having a reasonable potential to result in CSO volume reduction, is constructable and has an identifiable means of gaining access to necessary lands.

The screening for each CSO location indicates that the most feasible control measures include inflow and infiltration reduction through renewal and separation, collection system capacity improvements, inline storage, and pump station upgrades. Offline storage may also be feasible control measures in the vicinity of CSO #006 and CSO #018; however, any offline storage facility will present significant challenges associated with land acquisition, permitting, and operations and maintenance without providing additional capacity or robustness to the overall collection system.

Table 4-2: CSO #005 Control Measure Screening

Control Measure	Feasible	Non-Feasible	Advantages	Disadvantages
I/I Reduction Program - Rehabilitation to Prevent Infiltration	X		Prevents groundwater from entering the combined system, reserving system storage and conveyance capacity for sewerage.	Rehabilitation may be extensive compared to impact on CSO volume.
Separation		X	Prevents surface water inflow from entering the combined system, reserving system storage and conveyance capacity for sewerage.	CSO #005 sewershed is largely separated, therefore, remaining combined sewer has significantly less impact on CSO volume than groundwater influence.
Collection System Renewal	X		Reduces potential for groundwater infiltration; provides opportunity for additional capacity; reduces liability of aging and failing infrastructure.	Projects are generally extensive, invasive, and expensive.
Collection System Capacity Improvements	X		May relieve surcharging and potential overflows by lowering the Hydraulic Grade Line (HGL) in the system.	Requires extensive conveyance upgrades from CSO #005 to the Pearl Street Pump Station.
Pump Station Upgrade	X		Combined with upstream improvements, increases conveyance capacity of the system, which could relieve surcharging at overflow locations.	Requires extensive conveyance system upgrades to match capacity upgrades at the pump station. Very high capital investment to reduction ratio.
Satellite Treatment		X	Provides some water quality improvement at the outfall during overflow events.	Requires land area that is not readily available to implement.
CSO Storage – Inline	X		Provides in-system peak flow storage capacity, potentially without additional pump station upgrades or extensive conveyance capacity upgrades. Likely a passive system.	High capital investment; moderate operations and maintenance cost. Hydraulics of the system are such that benefit would be minimal.
CSO Storage – Offline		X	Provides off-line peak flow storage capacity, potentially without additional pump station upgrades or extensive conveyance capacity upgrades.	Requires land that is not available.

Table 4-3: CSO #006 Control Measure Screening

Control Measure	Feasible	Non-Feasible	Advantages	Disadvantages
I/I Reduction Program - Rehabilitation to Prevent Infiltration	X		Prevents groundwater from entering the combined system, reserving system storage and conveyance capacity for sewerage.	Rehabilitation may be extensive compared to impact on CSO volume.
Separation	X		Prevents surface water inflow from entering the combined system, reserving system storage and conveyance capacity for sewerage	Separating and conveying flow from remaining combined sewershed will likely require extensive utility relocation.
Collection System Renewal	X		Reduces potential for groundwater infiltration; provides opportunity for additional capacity; reduces liability of aging and failing infrastructure.	Projects tend to be extensive, invasive, and expensive.
Collection System Capacity Improvements	X		May relieve surcharging and potential overflows by lowering the HGL in the system.	Requires extensive conveyance upgrades from CSO #006 to the Pearl Street Pump Station.
Pump Station Upgrade	X		Increases ultimate conveyance capacity of the system, which could relieve surcharging at overflow locations.	Requires extensive conveyance system upgrades to match capacity upgrades at the pump station.
Satellite Treatment		X	Provides some water quality improvement at the outfall during overflow events.	Requires land area that is not readily available
CSO Storage - Inline	X		Provides in-system peak flow storage capacity, potentially without additional pump station upgrades or extensive conveyance capacity upgrades. Likely a passive system.	High capital investment; moderate operations and maintenance cost; likely location (between CSO #005 and CSO #006) is narrow ROW.
CSO Storage - Offline	X		Provides off-line peak flow storage capacity, potentially without additional pump station upgrades or extensive conveyance capacity upgrades.	Requires land that is not readily available; high capital investment; high operations and maintenance cost. Potential location near CSO #006 requires land acquisition.

Table 4-4: CSO #018 Control Measure Screening

Control Measure	Feasible	Non-Feasible	Advantages	Disadvantages
I/I Reduction Program Rehabilitation to Prevent Infiltration	X		Prevents groundwater from entering the combined system, reducing peak system flow	Scope of necessary work to realize benefit during design storm may be extensive compared to impact on CSO volume.
Separation	X		Prevents surface water inflow from entering the combined system, reserving system storage and conveyance capacity for sewerage.	Separating and conveying flow from remaining combined sewershed will likely require extensive utility relocation.
Collection System Renewal		X	Reduces potential for groundwater infiltration; provides opportunity for additional capacity; reduces liability of aging and failing infrastructure.	Projects may be extensive, invasive, and expensive. Groundwater influence is significantly less than the influence of inflow and downstream conveyance limitations on CSO volumes.
Collection System Capacity Improvements		X	May relieve surcharging and potential overflows by lowering the HGL in the system	Requires extensive conveyance upgrades from the Front St Pump Station to the Main Plant Pump Station.
Pump Station Upgrade		X	Increases ultimate conveyance capacity of the system, which could relieve surcharging at overflow locations.	Requires extensive system upgrades to match capacity upgrades at the pump station. Downstream limitations must be identified and eliminated.
Satellite Treatment		X	Provides some water quality improvement at the outfall during overflow events.	Requires land is not readily available; high capital investment for little reduction; added operations & maintenance cost.
CSO Storage - Inline		X	Provides in-system peak flow storage capacity, potentially without additional pump station upgrades or extensive conveyance capacity upgrades. Likely a passive system.	Requires land is not readily available; high capital investment for little reduction; added operations & maintenance cost
CSO Storage - Offline	X		Provides off-line peak flow storage capacity, potentially without additional pump station upgrades or extensive conveyance capacity upgrades.	Requires land that is not readily available; high capital investment for little reduction; added operations & maintenance cost.

Table 4-5: CSO #024 Control Measure Screening

Control Measure	Feasible	Non-Feasible	Advantages	Disadvantages
I/I Reduction Program - Rehabilitation to Prevent Infiltration	X		Eliminates groundwater from entering the combined system, reserving system storage and conveyance capacity for sewerage	Extent of necessary work is unknown. Rehabilitation may be extensive compared to impact on CSO volume.
Collection System Renewal	X		Reduces potential for groundwater infiltration; provides opportunity for additional capacity; reduces liability of aging and failing infrastructure.	Projects may be extensive, invasive, and expensive.
Collection System Capacity Improvements	X		May relieve surcharging and potential overflows by lowering the HGL in the system.	Requires extensive conveyance upgrades from CSO #024 to the Pearl Street Pump Station
Pump Station Upgrade	X		Increases conveyance capacity of the system, which may relieve surcharging at overflow locations.	Requires extensive system upgrades to match capacity upgrades at the pump station.
Satellite Treatment		X	Provides some water quality improvement at the outfall during overflow events.	Requires land area that is not readily available
CSO Storage - Inline	X		Provides in-system peak flow storage capacity, potentially without additional pump station upgrades or extensive conveyance capacity upgrades. Likely a passive system.	High capital investment; moderate operations and maintenance cost.
CSO Storage - Offline	X		Provides off-line peak flow storage capacity, potentially without additional pump station upgrades or extensive conveyance capacity upgrades.	Likely location between CSO #006 and CSO #024 is very narrow and adjacent to RR ROW; high capital investment; high operations and maintenance cost.

5. ALTERNATIVES ANALYSIS

In consideration of the system modeling and known limitations to date and based on the prioritization and alternative screening documented in the previous section, we identified and evaluated abatement alternatives directed at reducing inflow and infiltration (source reduction), increasing conveyance capacity, and storage. Table 5-1 below summarizes the alternatives evaluated, and the following narrative describes each alternative in greater detail and present the results of the analysis.

Table 5-1: Summary of Abatement Alternatives

Alternative		Applicable CSO	Control Measure
1	Targeted Infiltration Study & Renewal Program	CSO #005, #006, #024	Source Reduction
2	Targeted Inflow Separation Program	CSO #005, #006, #024	Source Reduction
3	Combination of Alternatives 1 + 2	CSO #005, #006, #024	Source Reduction
4	Flow Control Upstream of CSO #005	CSO #005 and CSO #006	Inline Storage
5	Inline Storage Upstream of CSO #005	CSO #005 and CSO #006	Inline Storage
6	Raise CSO #005 Weir	CSO #005	Inline Storage
7	Raise CSO #006 Weir	CSO #006	Inline Storage
8	Broadway & Evans Parallel Sewer	CSO #006 and CSO #024	Inline Storage
9	Increase Conveyance Capacity from CSO #006 to Pearl St Pump Station	CSO #006 and CSO #024	Conveyance Capacity Increase
10	Increase Pearl St Pump Station Capacity	CSO #006 and CSO #024	Conveyance Capacity Increase
11	Offline Storage Between CSO #006 and CSO #024	CSO #006 and CSO #024	Offline Storage
12	Offline Storage Between CSO #005 and CSO #006	CSO #006	Offline Storage
13	Targeted Inflow Study & Separation Program	CSO #018	Source Reduction
14	Offline Storage at Front St Pump Station	CSO #018	Offline Storage
15	Targeted Infiltration Study & Renewal Program	CSO #018	Source Reduction

5.1 Alternative Descriptions

A total of 15 alternatives were evaluated with detailed descriptions provided in the following subsections. Appendix A-2 shows the relative location of all alternatives identified.

5.1.1 Alternative 1 – Targeted Infiltration Study & Renewal Program

Applicable CSOs: #005, #006 and #024 (west side of collection system)

Control Measure: Source Reduction

Location: Area 1 – Sunset Park Neighborhood (Massachusetts Ave, Pennsylvania Ave, New York Ave); Wallace Ave; Union St; Tremont St; Wilson St; Gerry St; Mclean St; Carrigan Ave; Thornton Ave; Cornell St; and Memory Ln

Area 2 – Pleasant Ave; Park Ave; Chambers Ave; Hemco Rd; and Dartmouth St

Area 3 - Huntress Ave; Alton St; Bishop Ave; and Haskell Ave

Description: Based on the results of collection system metering and modeling, areas shown in Figure 5-1 below have been identified as the most likely contributors to groundwater infiltration. This alternative consists of studying the extent of groundwater influence through additional metering of these three areas, performing CCTV inspections to supplement the City's asset management data, and smoke testing to identify possible inflow sources. Using results of this analysis and inspection, portions of the system with advanced deterioration would be replaced, and collection pipes with minor defects would be lined to prevent further infiltration. For the purposes of this analysis, a total groundwater infiltration volume reduction of 35% was assumed.

Conceptual layouts for each area within this alternative are included as Appendix C-1.

Figure 5-1: Alternative 1

5.1.2 Alternative 2 – Targeted Inflow Separation Program

Applicable CSOs: #005, #006 and #024 (west side of collection system)

Control Measure: Source Reduction

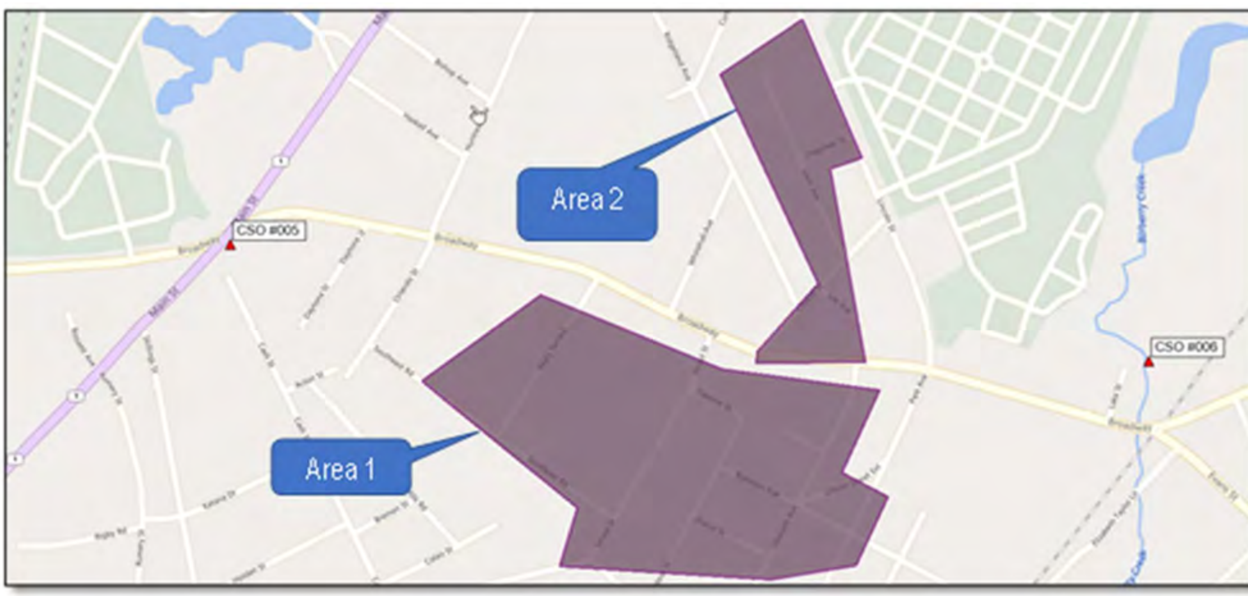
Location: Area 1 – Peary Terrance; Southeast Rd; Strout St; Thadeus St; Pleasant Ave; Bowdoin Ave; and Dracut Ave

Area 2 – Lawn Ave; Chapman St; Lincoln St; Church St; and Lee Ave

Description: Based on the results of collection system metering and modeling, areas shown in Figure 5-2 have been identified as the most likely contributors to surface runoff entering the collection system. This alternative consists of designing and constructing sewer separation projects to eliminate wet weather inflow. This alternative will result in the separation of 27 catch basins on 9 streets from the combined system and requires 10,140 feet of new separated storm drain pipe. For the purposes of this analysis, a total inflow reduction of 50% of the peak inflow was assumed.

Conceptual layouts for each area within this alternative are included as Appendix C-2.

Figure 5-2: Alternative 2



5.1.3 Alternative 3 – Combination of Alternatives 1 + 2

Applicable CSOs: #005, #006 and #024 (west side of collection system)

Control Measure: Source Reduction

Location: Areas outlined in Alternatives 1 and 2 above

Description: Combination of the infiltration and inflow reduction work described in Alternatives 1 and 2. Due to the dynamic nature of the collection system, the results of infiltration and inflow reductions are not necessarily additive; therefore, as shown on Figure 5-3, the combined alternatives were simulated together dynamically with both the modifications applied to Alternative 1 and Alternative 2.

Figure 5-3: Alternative 3

5.1.4 Alternative 4 – Flow Control Upstream of CSO #005

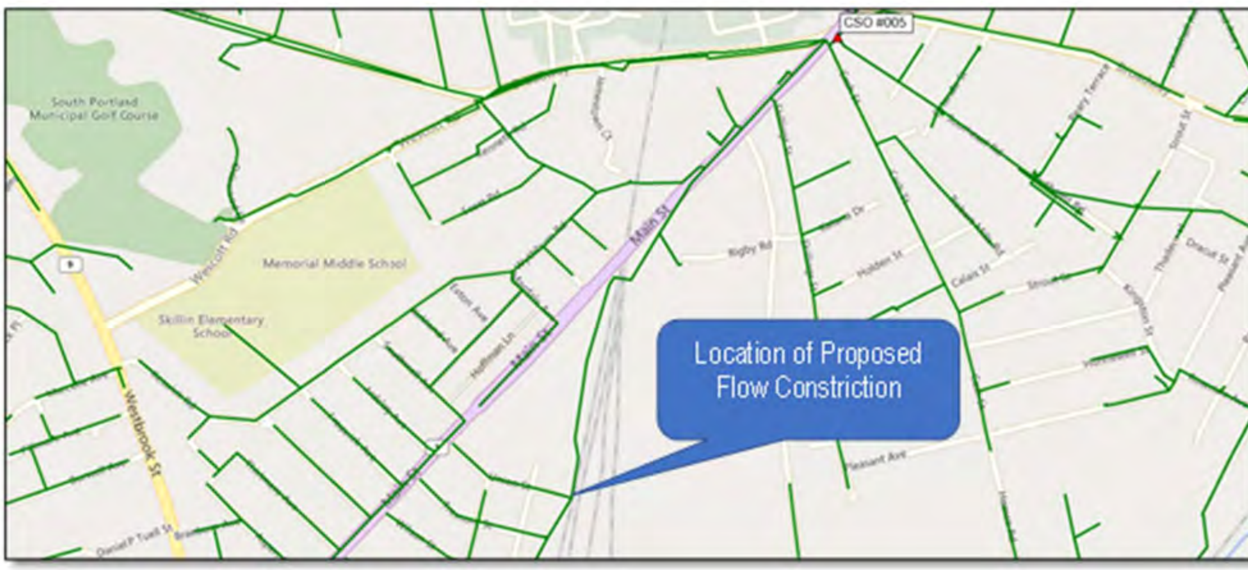
Applicable CSOs: #005, #006 and #024 (west side of collection system)

Control Measure: Inline Storage

Location: Union Street

Description: Simulation of the combined system indicates that a portion of the collection system upstream of CSO #005 in the cross-country run adjacent to the rail line does not surcharge during the design event, indicating potentially available flow or volume capacity. Installation of a flow control measure located near the east end of Union Street could be utilized to delay peak flows and maximize existing storage as shown on Figure 5-4.

Figure 5-4: Alternative 4



5.1.5 Alternative 5 – Inline Storage Upstream of CSO #005

Applicable CSOs: #005, #006 and #024 (west side of collection system)

Control Measure: Inline Storage

Location: Sunset Ave, from approximately the end of Tremont Street to approximately the end of Thornton Avenue

Description: Includes approximately 1,700 linear feet of 4 feet high by 6 feet wide box conduit for inline combined sewer storage, as shown on Figure 5-5.

Figure 5-5: Alternative 5

5.1.6 Alternative 6 – Raise CSO #005 Weir

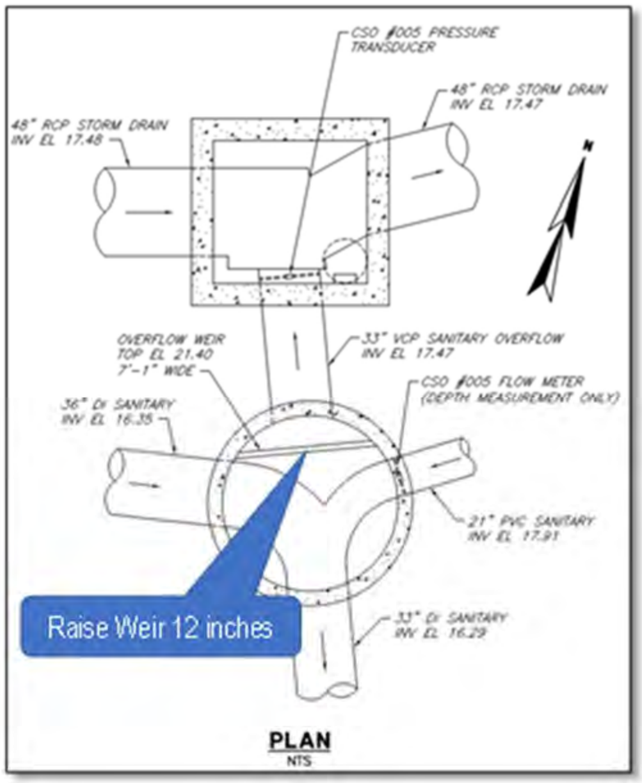
Applicable CSOs: #005 (west side of collection system)

Control Measure: Inline Storage

Location: CSO #005 Regulator

Description: Includes raising the weir on the CSO #005 regulator structure from elevation 21.13 to 22.13 as shown on Figure 5-6.

Figure 5-6: Alternative 6



5.1.7 Alternative 7 – Raise CSO #006 Weir

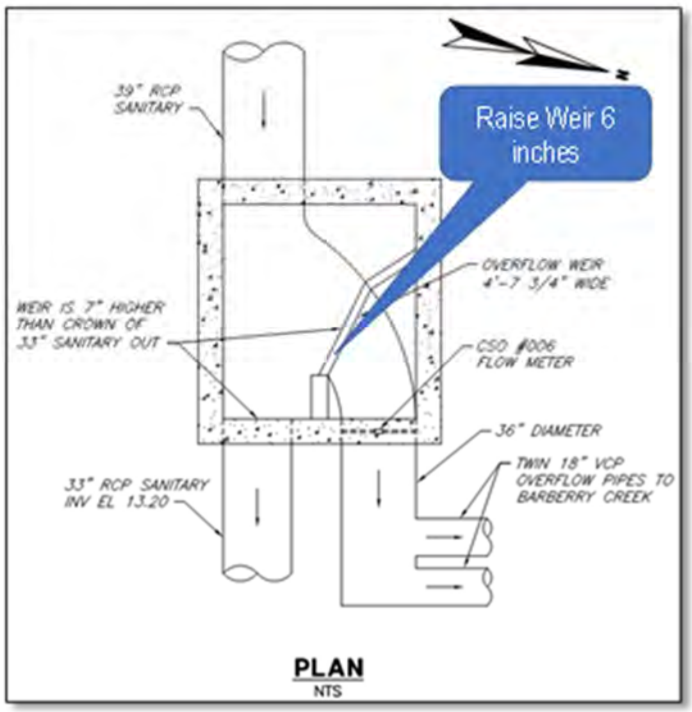
Applicable CSOs: #006 (west side of collection system)

Control Measure: Inline Storage

Location: CSO #006 Regulator

Description: Includes raising the weir on the CSO #006 regulator structure from elevation 17.07 to 17.57.

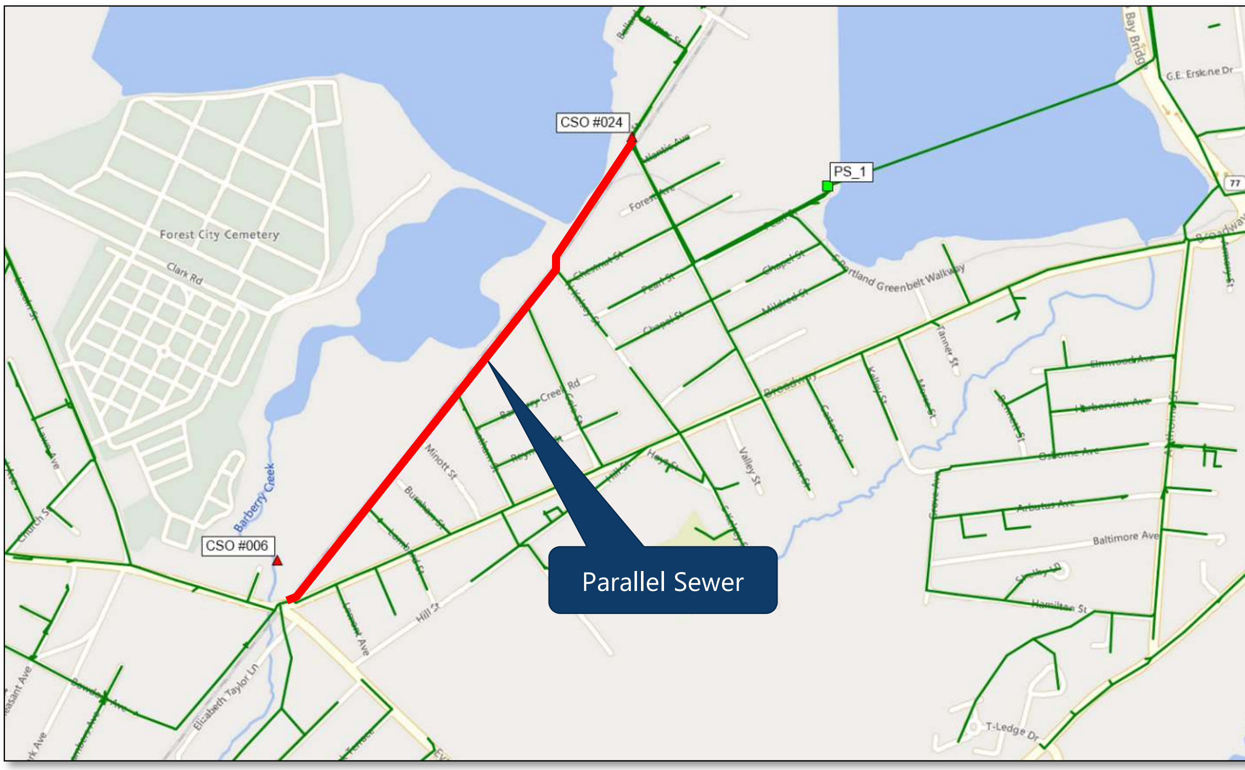
Figure 5-7: Alternative 7



5.1.8 Alternative 8 – Broadway & Evans Parallel Sewer

Applicable CSOs:	#005, #006 and #024 (west side of collection system)
Control Measure:	Inline Storage
Location:	Greenbelt Walkway
Description:	Includes construction of a parallel 36-inch diameter sanitary sewer between CSO #006 and CSO #024 as shown on Figure 5-8. The conceptual layout for this alternative is depicted in Appendix C-3.

Figure 5-8: Alternative 8



5.1.9 Alternative 9 – Increase Conveyance Capacity from CSO #006 to Pearl St Pump Station

5.1.9.1 Option A – Existing Conveyance Route Replacement

Applicable CSOs: #005, #006 and #024 (west side of collection system)

Control Measure: Conveyance Capacity Increase

Location: Greenbelt Walkway; Elm Street; Pearl Street

Description: Includes reconstruction of the conveyance piping from CSO #006 to the Pearl Street Pump Station. The existing 33-inch restriction just downstream of the CSO #006 regulator would be replaced with a 36-inch diameter pipe, and the next 1,500 feet of pipe to approximately the northwest end of Latham Street would be replaced with 54-inch conduit for inline storage. The remainder of the pipe, approximately 3,700 feet to CSO #024 and on to the Pearl Street Pump Station would be replaced with 36-inch diameter pipe with a typical slope of 0.002. The reconstruction of sanitary sewer from the intersection of Elm Street and Pearl Street to the pump station would be included in the Pearl Street Pump Station upgrade project (Alternative 10).

The location of this alternative is shown in Figure 5-9A below, and the conceptual layout for this alternative is depicted in Appendix C-4.

Figure 5-9A: Alternative 9 – Option A

5.1.9.2 Option B – Alternate Conveyance Route / Elm St Bypass

Applicable CSOs: #005, #006 and #024 (west side of collection system)

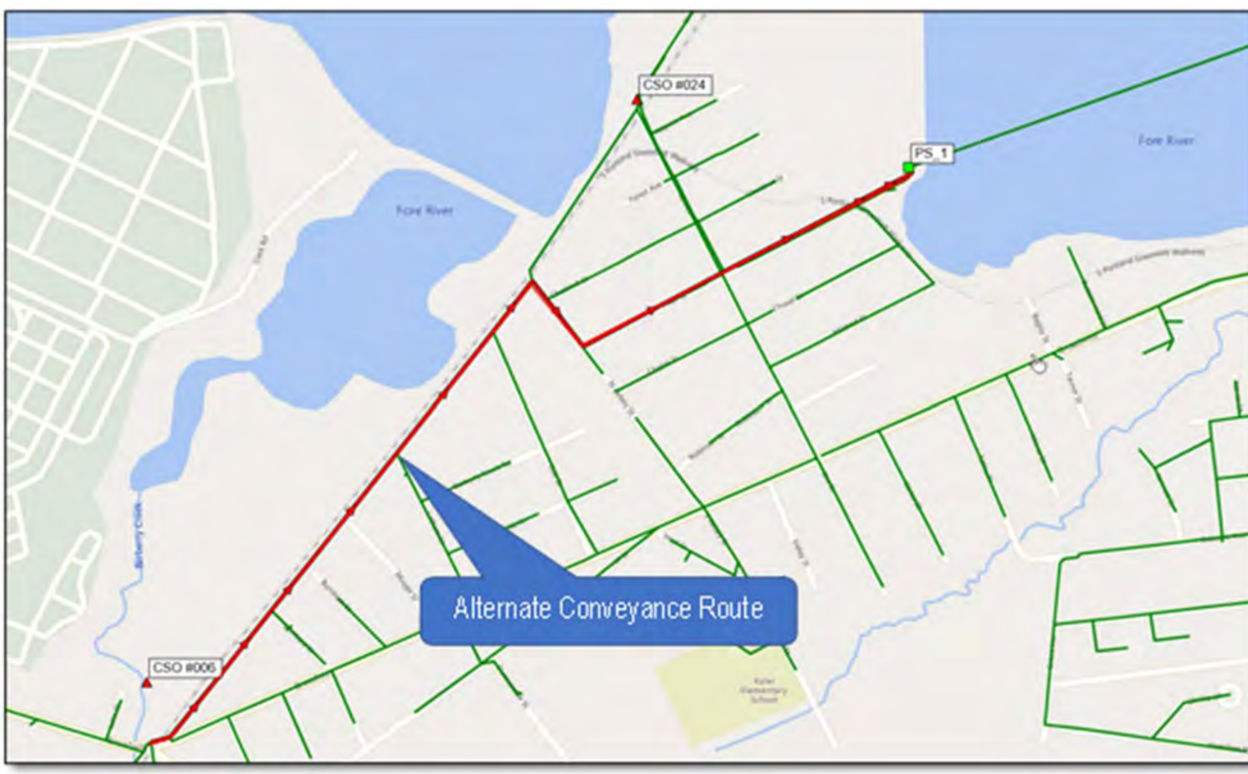
Control Measure: Conveyance Capacity Increase

Location: Greenbelt Walkway; North Kelsey Street; Pearl Street

Description: Includes reconstruction of the conveyance piping from CSO #006 to the west end of North Kelsey Street. The existing 33-inch restriction just downstream of the CSO #006 regulator would be replaced with a 36-inch diameter pipe, and the next 1,500 feet of pipe to approximately the northwest end of Latham Street would be replaced with 54-inch conduit for inline storage. From that point, existing conveyance pipe would be replaced with 36-inch diameter pipe to the northwest end of North Kelsey Street, then rerouted south along North Kelsey Street, and ultimately east along Pearl Street to the pump station (approximately 2,900 feet). The entire profile would be constructed at a typical slope of 0.002. The reconstruction of sanitary sewer from the intersection of Elm Street and Pearl Street to the pump station would be included in the Pearl Street Pump Station upgrade project (Alternative 10).

The location of this alternative is shown in Figure 5-9B below, and the conceptual layout for this alternative is depicted in Appendix C-5.

Figure 5-9B: Alternative 9 – Option B



5.1.9.3 Option C – Conveyance Replacement with Inline Storage

Applicable CSOs: #005, #006 and #024 (west side of collection system)

Control Measure: Conveyance Capacity Increase

Location: Greenbelt Walkway

Description: Includes reconstruction of the conveyance piping from CSO #006 to the west end of North Kelsey Street. The existing 33-inch restriction just downstream of the CSO #006 regulator would be replaced with a 36-inch diameter pipe, and the next 2,100 feet to approximately the northwest end of Cole Street would be replaced with 36-inch diameter pipe. The next 1,150 feet of pipe, not including the railroad crossings, would be replaced by 54-inch conduit for inline storage. This alternative also requires raising the weir at the CSO #024 regulator by approximately 18 inches to elevation 10.5. Hydraulic impacts and the potential benefit of a bending weir to accommodate more extreme events would be evaluated during final design.

The location of this alternative is shown in Figure 5-9C below, and the conceptual layout for this alternative is depicted in Appendix C-6.

Figure 5-9C: Alternative 9 – Option C

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5.1.10 Alternative 10 – Increase Pearl St Pump Station Capacity

Applicable CSOs: #005, #006 and #024 (west side of collection system)

Control Measure: Conveyance Capacity Increase

Location: East End of Pearl Street

Description: Includes upgrading the Pearl Street Pump Station, which currently handles all flow from the western side of the City, to a peak capacity of 18 MGD and upgrading sanitary sewer from the intersection of Elm Street and Pearl Street to the pump station to 36-inch diameter pipe (approximately 950 linear feet). This alternative must be executed in conjunction with Alternative 9, Options A, B or C to realize the benefits of the conveyance improvements.

5.1.11 Alternative 11 – Offline Storage Between CSO #006 and CSO #024

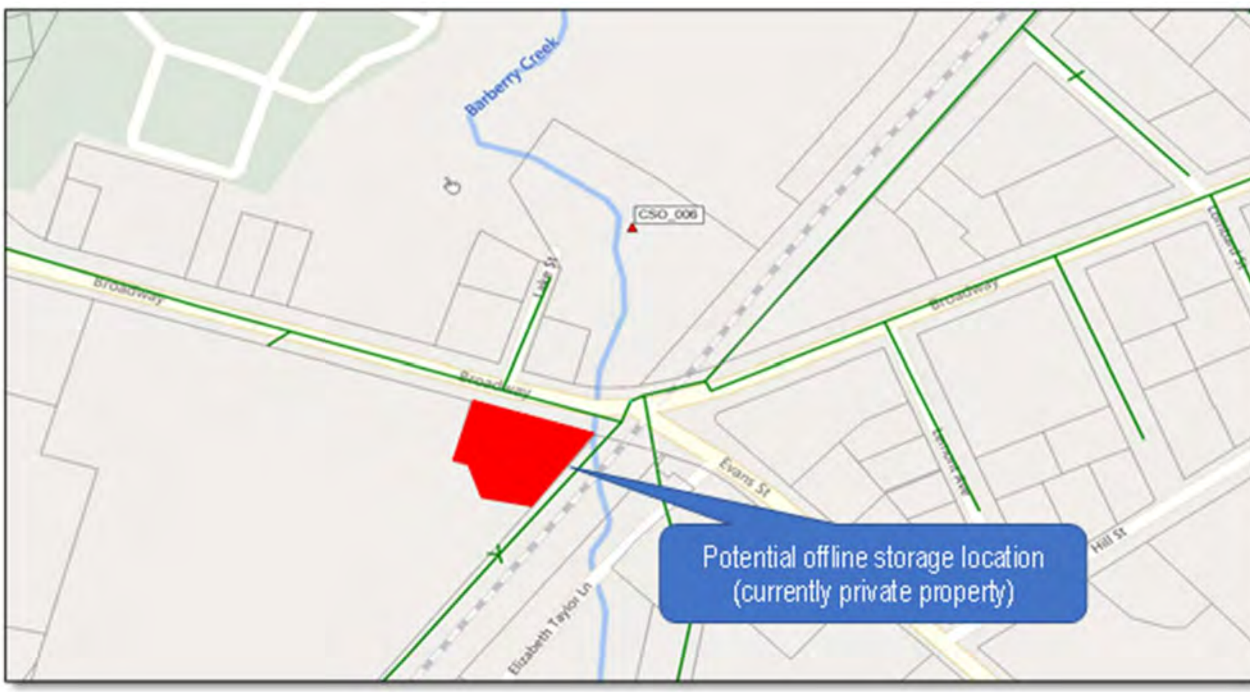
Applicable CSOs: #005, #006 and #024 (west side of collection system)

Control Measure: Offline Storage

Location: Intersection of Broadway & Evans

Description: Includes the construction of a 1 million-gallon offline storage facility in the vicinity of CSO #006, potentially in the vacant lot directly to the west of the intersection of Elm Street and Broadway. The storage facility is assumed to consist of one or more underground tanks which fill by gravity. Flow would be diverted upstream of the existing CSO #006 regulator weir by a transverse weir. The storage facility would require a lift station to drain the tanks following the completion of a wet weather event. A dewatering force main would tie into the gravity sewer system downstream of the CSO #006 regulator. The tanks would also require cleaning capabilities such as tipping buckets or flushing gates to remove sediment from the tanks. The potential location of this alternative is shown in Figure 5-10 below.

Figure 5-10: Alternative 11



5.1.12 Alternative 12 – Offline Storage Between CSO #005 and CSO #006

Applicable CSOs: #005, #006 and #024 (west side of collection system)

Control Measure: Offline Storage

Location: Southeast Road

Description: Includes the construction of a 1 million-gallon offline storage facility between CSO #005 and #006, potentially under the ballfield located on the north side of Southeast Road. The storage facility is assumed to consist of one or more underground tanks which fill by gravity. Flow would be diverted from the 36-inch conveyance pipe by a transverse weir. The storage facility would require a lift station to drain the tanks following the completion of a wet weather event. A dewatering force main would tie into the gravity sewer system downstream of the diversion point. The tanks would also require cleaning capabilities such as tipping buckets or flushing gates to remove sediment from the tanks. The potential location of this alternative is shown in Figure 5-11 below.

Figure 5-11: Alternative 12

5.1.13 Alternative 13 – Targeted Inflow Study & Separation Program

Applicable CSOs: #018 (east side of collection system)

Control Measure: Source Reduction

Location: Area 1 – Cottage Road from Edgewood Road to Woodbury Street

Area 2 – Cottage Road from Sawyer Street to Pillsbury St

Description: Based on the results of collection system modeling, areas have been identified as likely contributors to surface runoff entering the collection system. This alternative consists of designing and constructing sewer separation projects to eliminate wet weather inflow. This alternative separates 41 catch basins on 6 streets from the combined system and requires 5,321 feet of new separated storm drain pipe.

The separation scope is broken into 2 areas, shown in Figure 5-12 below with a conceptual design included in Appendix C-7.

Figure 5-12: Alternative 13

5.1.14 Alternative 14 – Offline Storage at Front St Pump Station

Applicable CSOs: #018 (east side of collection system)

Control Measure: Offline Storage

Location: Front Street

Description: Includes the construction of a 0.3 million-gallon offline storage facility in the vicinity of the Front Street Pump Station, potentially in the vacant lot immediately west of the pump station. The storage facility is assumed to consist of one or more underground tanks which fill by gravity. Flow would be diverted upstream of the CSO #018 regulator weir by a transverse weir. Depending on the ultimate storage facility layout, it is possible the system could drain to the Front Street Pump Station wet well by gravity; however, for the purpose of this analysis, it is assumed that the facility will require a lift station to drain the tanks following the wet weather event. A dewatering force main would tie Front Street Pump Station wet well. The tanks would also require cleaning capabilities such as tipping buckets or flushing gates to remove sediment from the tanks. The potential location of this alternative is shown in Figure 5-13 below.

Figure 5-13: Alternative 14

5.1.15 Alternative 15 – Targeted Infiltration Study & Renewal Program

Applicable CSOs: #018 (east side of collection system)

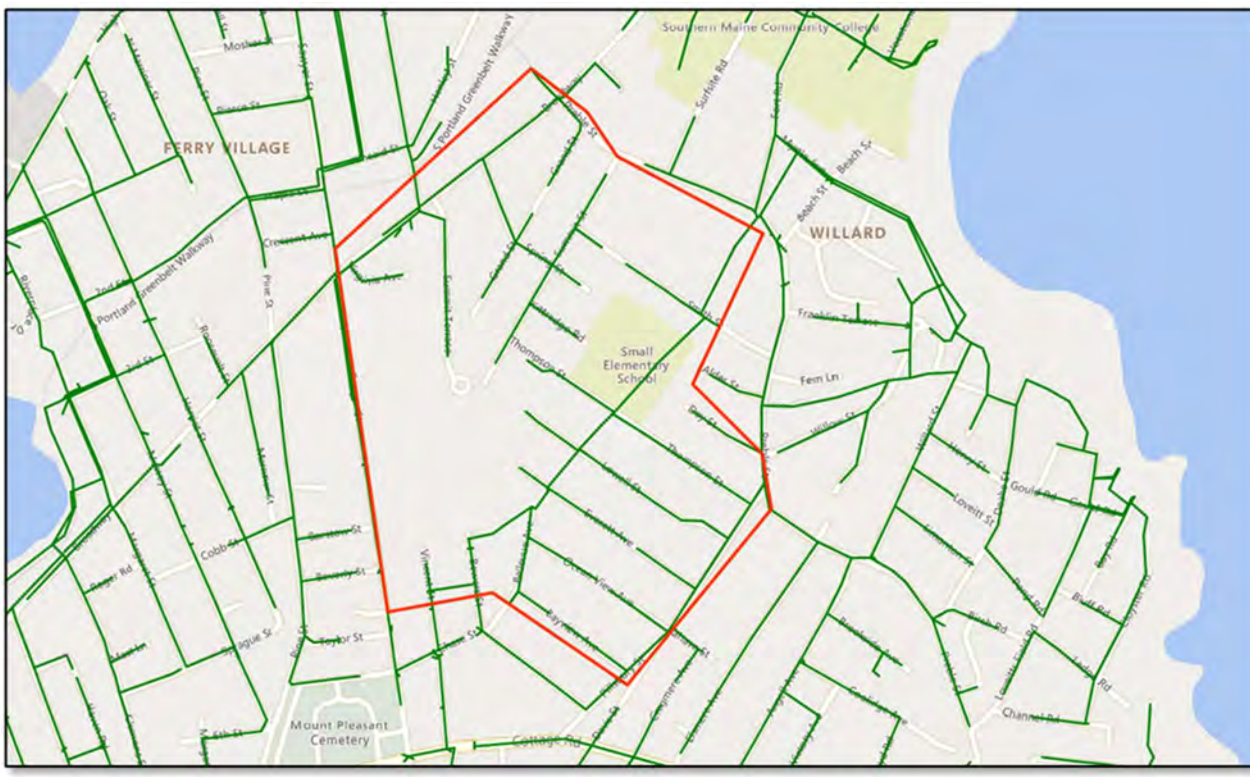
Control Measure: Source Reduction

Location: Throughout the contributing area

Description: Based on the results of the Front Street Pump Station modeling, the area shown in Figure 5-14 has been identified as the most likely contributor to groundwater infiltration. This alternative consists of studying the groundwater influence through metering of this area. Using results of this analysis and inspection, portions of the system with advanced deterioration would be replaced, and collection pipes with minor defects would be lined to prevent further infiltration.

A conceptual layout of defects and renewal priorities is included in Appendix C-8.

Figure 5-14: Alternative 15



5.2 Simulation Results

Each alternative was evaluated within the context of the existing collection system using the SWMM models described in Section 3 and Appendix B to identify potential CSO volume reduction. Table 5-2 below summarizes the CSO reduction results for each alternative.

Table 5-2: Simulation Results

Alternative		CSO Reduction (MG)	Remaining CSO Volume (MG)
1	Targeted Infiltration Study & Renewal Program	0.68	0.31
2	Targeted Inflow Separation Program	0.16	0.83
3	Combination of Alternatives 1 + 2	0.81	0.18
4	Flow Control Upstream of CSO #005	0.03	0.96
5	Inline Storage Upstream of CSO #005	0.10	0.89
6	Raise CSO #005 Weir	0	0.99
7	Raise CSO #006 Weir	0.10	0.89
8	Broadway & Evans Parallel Sewer	0.67	0.32
9	Increase Conveyance Capacity from CSO #006 to Pearl St Pump Station	0.99	0
10	Increase Pearl St Pump Station Capacity	See results for Alternative 9 above	
11	Offline Storage Between CSO #006 and CSO #024	0.99	0
12	Offline Storage Between CSO #005 and CSO #006	0.25	0.74
13	Targeted Inflow Study & Separation Program	0.30	0
14	Offline Storage at Front St Pump Station	0.30	0
15	Targeted Infiltration Study & Renewal Program	0.05	0.25

As summarized in Table 5-3, several alternatives were eliminated due to lack of benefit and/or planning and design considerations, such as required land acquisition, operations and maintenance requirements, and overall benefit to the collection system. For those alternatives selected, a conceptual design and cost estimate was prepared.

Table 5-3: Alternatives Advanced

Alternative		Selected for Advancement (Reasoning)
1	**Targeted Infiltration Study & Renewal Program**	**Yes**
2	**Targeted Inflow Separation Program**	**Yes**
3	**Combination of Alternatives 1 + 2**	**Yes**
4	Flow Control Upstream of CSO #005	No (lack of CSO reduction benefit)
5	Inline Storage Upstream of CSO #005	No (lack of CSO reduction benefit)
6	Raised CSO #005 Weir	No (lack of CSO reduction benefit)
7	**Raised CSO #006 Weir**	**Yes**
8	**Broadway & Evans Parallel Sewer**	**Yes**
9	**Increase Conveyance Capacity from CSO #006 to Pearl St Pump Station**	**Yes**
10	**Increase Pearl St Pump Station Capacity**	**Yes**
11	Offline Storage Between CSO #006 and CSO #024	No (land acquisition required, does not renew aging infrastructure)
12	Offline Storage Between CSO #005 and #006	No (land acquisition required, does not renew aging infrastructure)
13	**Targeted Inflow Study & Separation Program**	**Yes**
14	Offline Storage at Front St Pump Station	No (land acquisition required, does not renew aging infrastructure)
15	**Targeted Infiltration Study & Renewal Program**	**Yes**

6. EVALUATION OF GREATER STORM EVENT INTENSITY

During a draft implementation plan review meeting with the Maine DEP staff on November 4, 2021, additional analysis was requested. Consistent with the Maine DEP goal to reduce and close CSO locations that discharge to small and/or sensitive receiving waters, a request was made to evaluate alternatives that would mitigate discharge to CSO #005 and CSO #006 during higher intensity precipitation events, including the 5-year, 10-year, and greater events. Maine DEP subsequently provided a written response on November 15, 2021 (Appendix E). The comments and requests are summarized below:

- Identify and evaluate alternatives to eliminate overflows from the west side of the system (CSO #005 and CSO #006) during the 5-year event, 10-year event, and all events;
- Identify and evaluate alternatives to eliminate overflows from the east side of the system CSO #018 during the 5-year event, 10-year event, and all events; and
- Perform a Financial Capability Analysis to determine the financial burden on sewer customers.

The Maine DEP review noted that reducing overflows to sensitive receiving waters is a primary directive of the Department. The City of South Portland proposes to transition two CSOs into to emergency overflows for protection of the WWTF; one location for the west side of the collection system (CSO #024) and one location for the east side of the collection system (CSO #018). The west and east sides are topographically distinct geographic regions, collecting flow independently and delivering it to the WWTF in parallel. CSO #024 must be maintained to protect the Pearl Street Pump Station and surrounding neighborhood from flooding, but it offers no protection to the Front Street Pump Station and surrounding neighborhood. CSO #018 must be maintained to protect the Front Street Pump Station from flooding in addition to the surrounding neighborhood, which includes substantial existing commercial operations and proposed residential developments.

The following narrative addresses the request from Maine DEP to evaluate mitigation of greater storm events and summarize findings and recommendations related to further mitigation of CSO #005 and #006.

6.1 Updates to the West Side Collection System Hydraulic Model

Evaluating larger storm events required that the hydraulic model be updated. During these events, CSO overflows are impacted by greater interaction between the combined system and the separated storm drain system, as well as the tidal elevation. In particular, CSO #005 and CSO #024 regulator structures discharge to a separated storm drain pipe.

The current model is calibrated based on metering data that did not include any CSO events and was developed and calibrated for small (<10-year) storms. It is our opinion that the model is suitable for extrapolating system performance to the 2-year and 5-year return period events. The calibrated model used for the alternatives analysis targeting the 2-year precipitation event is not suitable for use in evaluating storms larger than the 5-year return period, i.e. 10-year and greater. As the event simulated gets further from the data used to calibrate the model, the uncertainty associated with the result is compounded. Furthermore, the nature of a 5- or 10-year event differs from a 2-year event, as the extent of flooding and overland flow increases dramatically with increased rainfall intensity. As a 1-dimensional collection system representation, the current model does not explicitly account for overland flow and its potential interactions with the combined sewer system. An alternative for mitigating the 10-year event on the west side of the collection system has been included as a point of reference but is not recommended. By extension, greater events were not evaluated.

6.1.1 Model Modifications

To evaluate the larger storms (5-year and 10-year), several model updates were completed so the model could produce stable results and account for additional factors, including tidal influence and storm drain systems that interact with the combined sewer during larger storms. The model modifications included adjustments to the model simulation parameters, adding stormwater to the CSO #005 and CSO #024 outfall lines, and accounting for tidal backwater to the CSO #024 outfall. These modifications are described below with the results of the analyses.

6.1.1.1 Simulation Parameters

The previous model utilized the USEPA SWMM version 5.013 with a 10-second timestep. To improve model stability during the larger storms, the time step was decreased to 5-seconds and a newer version of the model software was used (version 5.015). The newer version of the software includes the ability to average the results over the printout frequency. The printout frequency was decreased from 15 minutes to 5 minutes to better represent rapidly changing water levels and flows. The updated simulation parameters resulted in more stable results, which were easier to interpret.

6.1.1.2 Tidal Impacts

The CSO #024 discharges into the Fore River, which is tidally influenced. To account for potential tidal tailwater conditions, the 5-year and 10-year tidal backwater were estimated from the effective FEMA FIS and were converted to the City of South Portland datum. These resulted in a tidal backwater elevation of 7.6 feet for the 5-year storm and 8.28 feet for the 10-year storm. It is noted that the CSO #024 weir is at elevation 8.9 feet, providing limited difference in elevation between the weir elevation and the peak tidal elevation.

6.1.1.3 Stormwater

The capacity of the storm drains downstream of the CSO #005 and CSO #024 regulators may be limited during larger storms because of the increased flow from the upstream separated storm drain system, and therefore could impact CSO flows and upstream water levels. The stormwater contributing areas and downstream piping system were added to the model to estimate the impact of the stormwater from these areas on the combined sewer collection system.

6.1.1.3.1 CSO #005

The CSO #005 regulator discharges into a 48-inch storm drain which discharges into a wetland about 500 feet to the north on Main Street. There is approximately 175 acres of stormwater runoff contributing flow into the storm drain upstream of the connection from the CSO #005 regulator and another 3 acres that drains to the outfall line downstream from the regulator. The contributing stormwater area is shown in Figure 6-1. The stormwater areas and outfall line were added to the collection system model, which indicates stormwater likely backflows over the weir and enters the combined sewer collection system during larger storms.

Figure 6-1: Stormwater Collection Area Draining to CSO #005 Outfall

6.1.1.3.2 CSO #006

The CSO #006 regulator discharges into a dedicated outfall pipe that does not convey stormwater.

6.1.1.3.3 CSO #024

The CSO #024 regulator discharges into a 36-inch storm drain which discharges into the Fore River near Mechanic Street. There is approximately 27 acres of contributing stormwater flow to the pipe upstream of the connection from the CSO #024 regulator and another 11 acres that contributes to the outfall line downstream from the regulator. The stormwater areas and outfall line were added to the collection system model, which, with the tidal backwater conditions, results in stormwater backflowing over the weir and entering the collection system during larger storms. The contributing stormwater area is shown in Figure 6-2.

Figure 6-2: Stormwater Collection Area Draining to CSO #024 Outfall

6.1.1.4 Simulation Results

Table 6-1 below shows the overflow volumes for the system under existing conditions, comparing the 2-year, 5-year, and 10-year design storm under medium groundwater conditions.

Table 6-1: Existing Condition Overflow Volumes

CSO Location	Overflow Volume (MG)		
	2-Year Storm	5-Year Storm[1]	10-Year Storm[1]
#005	0	0.35	0.79
#006	0.99	3.75	7.17
#024	0	0	0
Total	0.99	4.10	7.96

1. Overflow volume is dependent on tidal condition and storm drain interaction

6.2 Mitigation of 5- and 10-Year Events – West Side Collection System

To address Maine DEP comments, two additional alternatives were identified for the West Side Collection System to reduce overflow volumes during the 5- and 10-year storms.

6.2.1 Alternative 9, Option D – Alternate Conveyance Route / Elm St Bypass

Applicable CSOs: #005, #006 and #024 (west side of collection system)

Level of Control: **5-year Storm**

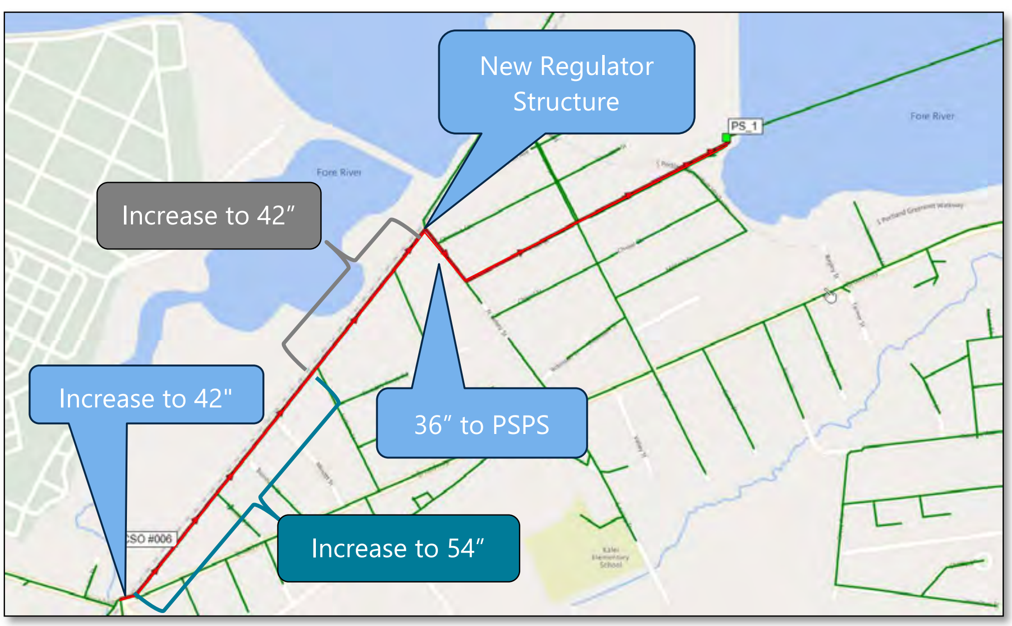
Control Measure: Conveyance Capacity Increase

Location: Greenbelt Walkway; North Kelsey Street; Pearl Street

Description: Includes reconstruction of the conveyance piping from CSO #006 to the west end of North Kelsey Street. The existing 33-inch restriction just downstream of the CSO #006 regulator would be replaced with a 42-inch diameter pipe to the Greenbelt Walkway, and the next downstream segment of 1,500 feet of pipe to approximately the northwest end of Latham Street would be replaced with 54-inch conduit for inline storage. From that point, existing conveyance pipe would be replaced with 42-inch diameter pipe to the northwest end of North Kelsey Street. From there, flows would be rerouted through a new 36-inch pipe south along North Kelsey Street, and ultimately east along Pearl Street to the pump station (approximately 2,550 feet). A regulator structure would be constructed at the northwest end of North Kelsey Street. The entire profile would be constructed at a typical slope of 0.002. The reconstruction of sanitary sewer from the intersection of Elm Street and Pearl Street to the pump station would be included in the Pearl Street Pump Station upgrade project (Alternative 10).

The location of this alternative is shown in Figure 6-3 below.

Figure 6-3: Alternative 9D



6.2.2 Alternative 16, Increased Capacity/Elm St Bypass

Applicable CSOs: #005, #006 and #024 (west side of collection system)

Level of Control: **10-year Storm**

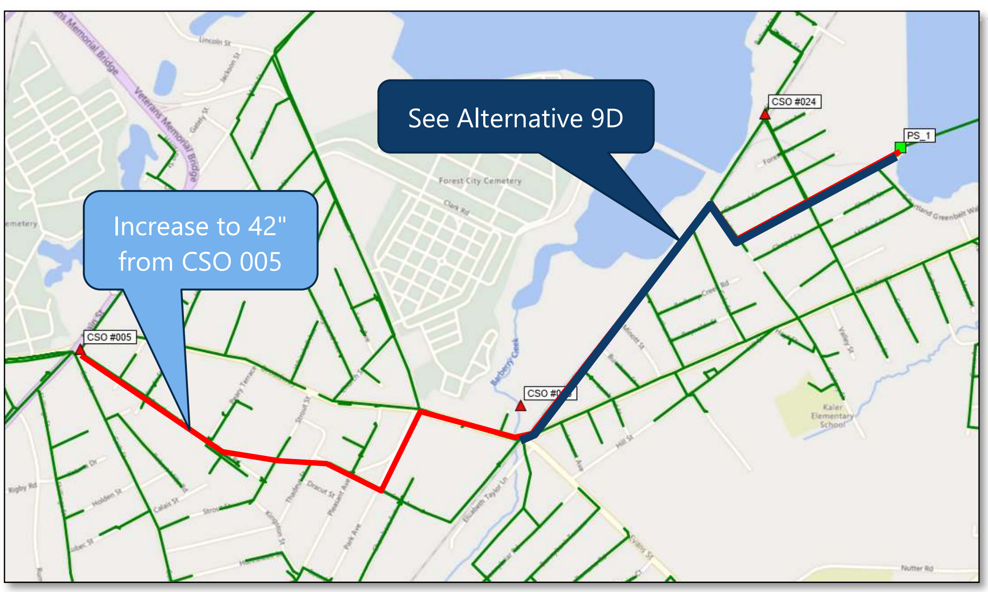
Control Measure: Conveyance Capacity Increase

Location: Southeast Road; Park Ave; Broadway Greenbelt Walkway; North Kelsey Street; Pearl Street

Description: Includes reconstruction of the conveyance piping from CSO #005 to CSO #006 and rerouting along Park Ave and Broadway to avoid private property. Existing 30- to 36-inch pipe will be replaced with 42- and 54-inch pipe. Includes reconstruction of conveyance piping from CSO #006 to the west end of North Kelsey Street. The existing 33-inch restriction just downstream of the CSO #006 regulator would be replaced with a 42-inch diameter pipe to the Greenbelt Walkway, and the next downstream segment of 1,500 feet of pipe to approximately the northwest end of Latham Street would be replaced with 54-inch conduit for inline storage. From that point, existing conveyance pipe would be replaced with 42-inch diameter pipe to the northwest end of North Kelsey Street. From there, flows would be rerouted through a new 36-inch pipe south along North Kelsey Street, and ultimately east along Pearl Street to the pump station (approximately 2,550 feet). The entire profile would be constructed at a typical slope of 0.002. The reconstruction of sanitary sewer from the intersection of Elm Street and Pearl Street to the pump station would be included in the Pearl Street Pump Station upgrade project (Alternative 10).

The location of this alternative is shown in Figure 6-4 below, and the conceptual layout for this alternative is depicted in Appendix C-9.

Figure 6-4: Alternative 16



6.2.3 Simulation Results

Tables 6-2 and 6-3 below show the simulation results for Alternative 9D, identified to abate the 5-year design storm, and Alternative 16, identified to abate the 10-year design storm, at CSOs #005 and #006.

Table 6-2: Alternative 9D Results (5-Year Storm)

CSO Location	Overflow Volume (MG)		
	5-Year Storm (Existing)	5-Year Storm (Proposed)	Change
#005	0.35	0	-0.35
#006	3.75	0	-3.75
#024	0	2.0	+2.0
Total	4.10	2.0	-2.10

Table 6-3: Alternative 16 Results (10-Year Storm)

CSO Location	Overflow Volume (MG)		
	10-Year Storm (Existing)	10-Year Storm (Proposed)	Change
#005	0.79	0	-0.79
#006	7.17	0	-7.17
#024	0	4.5	+4.5
Total	7.96	4.5	-3.46

Each alternative shifts overflows from CSO #005 and CSO #006 downstream to CSO #024 and reduces the total overflow volume by approximately 50% for each scenario. There is increased uncertainty associated with the simulation of the 10-year event, and these results are provided for comparison purposes only.

6.3 Mitigation of 5- and 10-Year Events – East Side Collection System

The simulations of the East Side Collection System indicate an overflow volume of 0.3 MG during a 2-year storm event and medium groundwater condition; however, the current model does not reflect some of the recently completed capacity upgrades in the conveyance system downstream of the Front Street Pump Station and ongoing separation projects in the contributing area. In contrast to the model, during the 2021 reporting period, there were no overflow events at CSO #018, despite a rainfall event totaling 4.1 inches in 6 hours and a total accumulation of 44.87 inches for the year. The 4.1-inch event corresponds to a 25-year return period, according to the NOAA Atlas 14 probability distributions shown in Figure 6-5 below:

Figure 6-5: NOAA Atlas 14 Probability Distributions

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.307 (0.252-0.373)	0.370 (0.304-0.451)	0.474 (0.388-0.580)	0.560 (0.455-0.689)	0.679 (0.528-0.873)	0.768 (0.582-1.01)	0.861 (0.629-1.17)	0.966 (0.660-1.35)	1.12 (0.728-1.61)	1.24 (0.785-1.83)
10-min	0.435 (0.357-0.529)	0.525 (0.431-0.639)	0.672 (0.549-0.821)	0.793 (0.644-0.975)	0.961 (0.748-1.24)	1.09 (0.824-1.43)	1.22 (0.891-1.66)	1.37 (0.936-1.91)	1.58 (1.03-2.29)	1.76 (1.11-2.59)
15-min	0.511 (0.420-0.622)	0.617 (0.507-0.752)	0.790 (0.646-0.966)	0.934 (0.758-1.15)	1.13 (0.880-1.45)	1.28 (0.970-1.68)	1.44 (1.05-1.96)	1.61 (1.10-2.25)	1.86 (1.21-2.69)	2.07 (1.31-3.05)
30-min	0.658 (0.541-0.800)	0.799 (0.656-0.974)	1.03 (0.842-1.26)	1.22 (0.992-1.50)	1.49 (1.16-1.91)	1.69 (1.28-2.21)	1.89 (1.38-2.58)	2.13 (1.45-2.96)	2.46 (1.60-3.55)	2.73 (1.73-4.02)
60-min	0.804 (0.661-0.978)	0.981 (0.805-1.20)	1.27 (1.04-1.55)	1.51 (1.23-1.86)	1.84 (1.43-2.37)	2.09 (1.58-2.74)	2.35 (1.71-3.20)	2.64 (1.81-3.68)	3.05 (1.99-4.41)	3.38 (2.14-4.99)
2-hr	1.13 (0.934-1.37)	1.38 (1.14-1.67)	1.79 (1.47-2.17)	2.12 (1.73-2.59)	2.59 (2.03-3.31)	2.94 (2.24-3.84)	3.31 (2.43-4.49)	3.73 (2.56-5.17)	4.34 (2.84-6.23)	4.85 (3.08-7.11)
3-hr	1.36 (1.13-1.64)	1.66 (1.37-2.00)	2.14 (1.77-2.59)	2.55 (2.09-3.10)	3.11 ([illegible])	3.52 (2.70-4.59)	3.97 (2.93-5.38)	4.48 (3.08-6.19)	5.24 (3.43-7.49)	5.87 (3.73-8.56)
6-hr	1.79 (1.50-2.14)	2.18 (1.82-2.62)	2.82 (2.35-3.39)	3.35 (2.77-4.05)	4.08 (3.23-5.17)	4.63 (3.57-6.00)	5.21 (3.87-7.03)	5.89 (4.07-8.08)	6.90 (4.53-9.80)	7.74 (4.94-11.2)
12-hr	2.24 (1.89-2.67)	2.73 (2.30-3.25)	3.53 (2.95-4.22)	4.20 (3.48-5.04)	[illegible] (4.07-6.44)	5.79 (4.49-7.46)	6.52 (4.87-8.75)	7.38 (5.12-10.1)	8.66 (5.71-12.2)	9.73 (6.23-14.0)
24-hr	2.61 (2.21-3.08)	3.21 (2.71-3.79)	4.20 (3.53-4.98)	5.01 (4.19-5.98)	6.14 (4.92-7.70)	6.98 (5.45-8.96)	7.88 (5.93-10.6)	8.97 (6.24-12.2)	10.6 (7.03-14.9)	12.0 (7.74-17.2)
2-day	2.87 (2.44-3.36)	3.60 (3.06-4.22)	4.79 (4.05-5.64)	5.77 (4.85-6.84)	7.13 (5.76-8.92)	8.13 (6.40-10.4)	9.23 (7.03-12.4)	10.6 (7.40-14.3)	12.8 (8.48-17.8)	14.7 (9.46-20.9)
3-day	3.10 (2.66-3.63)	3.89 (3.32-4.55)	5.17 (4.39-6.07)	6.23 (5.26-7.36)	7.70 (6.24-9.59)	8.77 (6.93-11.2)	9.95 (7.61-13.3)	11.5 (8.01-15.4)	13.9 (9.22-19.3)	16.0 (10.3-22.6)
4-day	3.34 (2.86-3.89)	4.15 (3.55-4.84)	5.48 (4.67-6.41)	6.58 (5.56-7.74)	8.09 (6.58-10.1)	9.20 (7.30-11.7)	10.4 (8.00-13.9)	12.0 (8.41-16.1)	14.5 (9.68-20.1)	16.8 (10.8-23.7)
7-day	4.00 (3.45-4.63)	4.85 (4.17-5.62)	6.23 (5.34-7.25)	7.37 (6.27-8.63)	8.95 (7.31-11.1)	10.1 (8.05-12.8)	11.4 (8.77-15.1)	13.0 (9.16-17.3)	15.7 (10.5-21.6)	18.0 (11.7-25.3)
10-day	4.64 (4.02-5.36)	5.51 (4.76-6.37)	6.93 (5.96-8.04)	8.11 (6.92-9.46)	9.73 (7.97-11.9)	10.9 (8.71-13.7)	12.2 (9.41-16.1)	13.9 (9.79-18.4)	16.5 (11.0-22.6)	18.8 (12.2-26.3)
20-day	6.59 (5.74-7.56)	7.55 (6.57-8.66)	9.11 (7.89-10.5)	10.4 (8.94-12.1)	12.2 (10.00-14.7)	13.5 (10.8-16.7)	14.9 (11.4-19.1)	16.5 (11.7-21.7)	18.9 (12.7-25.6)	20.8 (13.5-28.8)
30-day	8.23 (7.20-9.40)	9.27 (8.09-10.6)	11.0 (9.53-12.6)	12.4 (10.7-14.3)	14.3 (11.7-17.1)	15.8 (12.6-19.3)	17.3 (13.1-21.8)	18.8 (13.4-24.6)	21.0 (14.2-28.4)	22.6 (14.7-31.3)
45-day	10.3 (9.04-11.7)	11.4 (10.0-13.0)	13.3 (11.6-15.2)	14.8 (12.8-17.0)	17.0 (14.0-20.2)	18.6 (14.8-22.6)	20.2 (15.3-25.3)	21.8 (15.6-28.3)	23.8 (16.2-32.1)	25.3 (16.5-34.8)
60-day	12.0 (10.6-13.6)	13.2 (11.6-15.0)	15.3 (13.3-17.4)	16.9 (14.7-19.4)	19.2 (15.9-22.8)	21.0 (16.8-25.3)	22.7 (17.2-28.2)	24.4 (17.5-31.5)	26.4 (17.9-35.4)	27.9 (18.2-38.3)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Based on the lack of overflow during this event and throughout 2021, the recently completed capacity upgrades and ongoing separation projects within the East Side Collection System appear to be providing a level of protection consistent with a 25-year return period event. As a result of these observations, no additional mitigation measures are recommended or proposed within the East Side Collection System.

7. FINANCIAL ANALYSIS

7.1 Estimate of Probable Cost

Cost estimates were prepared for alternatives that provided the greatest CSO reduction as previously identified in Table 5-3. Itemized cost breakdowns of each are included in Appendix D and summarized in Table 7-1 below.

Table 7-1: Estimated Project Costs

Alternative		Estimated Cost (2022 Dollars)
1	Targeted Infiltration Study& Renewal Program	$9,400,000
2	Targeted Inflow Separation Program	$16,200,000
3	Combination of Alternatives 1 + 2	$25,600,000
7	Raise CSO #006 Weir	$50,000
8	Broadway & Evans Parallel Sewer	$6,300,000
9	Increase Conveyance Capacity from CSO #006 to Pearl St Pump Station Option A – Existing Conveyance Route Replacement	$12,000,000
	Option B – Alternate Conveyance Route / Elm St Bypass (36”)	$11,200,000
	Option C – Conveyance Replacement with Inline Storage	$6,900,000
	Option D – Alternate Conveyance Route / Elm St Bypass (42”)	$12,000,000[1]
10	Increase Pearl St Pump Station Capacity	$14,400,000
13	Targeted Inflow Study & Separation Program	$3,100,000
15	Targeted Infiltration Study & Renewal Program	$2,500,000[2]
16	Alternate Conveyance Route / Elm St Bypass (42”) and Replacement of conveyance from CSO #005 to CSO #006	$26,900,000[3]

1 – Alternative provides control for 5-year event during medium groundwater conditions
2 – $2.5 Million distributed over 10 years; $250,000 per year
3 – Alternative provides control for 10-year event based on the assumptions described in previous sections

7.1.1 Cost Estimate Assumptions

Estimates of probable cost of the selected alternatives were generated based on a conceptual layout of each alternative. Estimated costs of construction were developed based on similar recent construction in the Portland area, including as a primary source, the City of South Portland’s CSO separation and sewer improvement projects bid and constructed between 2019 and 2021. Average bid prices for major construction components of typical CSO projects were reviewed and adjusted to reflect recent construction costs. These adjusted unit prices generally apply to the major components specific to the CSO work including pipe and structures (manholes, catch basins).

For the preliminary evaluation of cost, other associated work necessary to complete the projects were developed on an area (square foot or square yard) basis or linear foot basis, using recent bid prices. It should be noted that the conceptual designs are based on limited information regarding subsurface soil conditions. Allowances for unsuitable soils excavation and replacement and allowances for ledge removal are generally based total project pipe length and an assumed depth of material encountered. These costs can be a significant factor in the overall cost of a project and may significantly impact future project costs. In the conveyance options, particularly Alternative 9, construction will likely encounter poor soils. The approach to addressing the soils is unknown. To account for the costs, a price premium was applied to pipes with greater than 15 depth of cover.

Quantities for lining and renewal projects were developed based on a review of the City's GIS sewer mapping in the target areas. The sewer pipes were categorized by material type mapping of pipe faults detected by the City's ongoing camera inventories were overlaid on the pipe materials. Unit pricing for lining and rehabilitation are based on the City's current lining program contract.

7.1.2 Allowances and Contingencies

The estimated project costs for all alternatives include additional cost allowances to provide a complete project cost. Those allowances include the following:

- 20% allowance for engineering design, permitting and construction administration.
- 25% allowance for estimating contingency per Association for the Advancement of Cost Estimating (AACE).
- 10% allowance for owner's contingency.
- Escalation was assigned assuming 6% for 2023 and an average of 4% per subsequent years for the implementation plan. At the time of this Facility Plan Update, the unpredictable nature of the market due to supply chain disruptions, labor shortages and international conflict has resulted in rapid escalation in the construction industry, and therefore, it is difficult to predict future escalation rates. See Table 9-1 for future project costs including escalation.

7.2 Cost-Benefit Comparison – 2-Year Storm

As described above, conceptual cost estimates were prepared for the selected alternatives. Tables 7-2 and 7-3 below compares the cost and benefit of each option, including "cost per gallon abated" as an indicator of the overall cost-effectiveness of the alternative. The cost comparison in Table 7-2 only includes alternatives targeting the 2-year design storm because the "cost per gallon abated" is not an appropriate measure for comparing different control levels. Section 7.3 includes a cost comparison for abating the 2-year, 5-year, and 10-year design storm events.

Table 7-2: Cost-Benefit Comparison (West Side of Collection System) – 2-Year Design Storm

Alternative		CSO Reductions (MG)	Remaining CSO Volume (MG)	Conceptual Project Cost (2022 Dollars)	Cost per Gallon Abated (2022 Dollars)
1	Targeted Infiltration Study & Renewal Program	0.69	0.31	$9.4M	$13.62
2	Targeted Inflow Separation Program	0.17	0.83	$16.2M	$95.29
3	Combination of Alternatives 1 + 2	0.82	0.18	$25.6M	$31.22
7	Raise CSO #006 Weir	0.10	0.89	$0.05M	$0.50

Alternative		CSO Reductions (MG)	Remaining CSO Volume (MG)	Conceptual Project Cost (2022 Dollars)	Cost per Gallon Abated (2022 Dollars)
8	Broadway & Evans Parallel Sewer	0.67	0.31	$6.3M	$9.40
9	Increase Conveyance Capacity from CSO #006 to Pearl St Pump Station Option A – Existing Conveyance Route Replacement	0.99	0	$12.0M	$12.12
	Option B – Alternate Conveyance Route / Elm St Bypass	0.99	0	$11.2M	$11.31
	Option C – Conveyance Replacement with Inline Storage	0.99	0	$6.9M	$6.97
10	Increase Pearl St Pump Station Capacity	Applies to Alternative 9			

The cost-benefit comparison of Options A, B and C of Alternative 9 does not consider the robustness of each Alternative. Option C does not address constrictions at the two railroad crossings and requires raising the CSO #024 weir by approximately 18 inches, making it more sensitive to antecedent groundwater conditions. It also leaves a 1,200-foot run of 75-100 year-old pipe at a depth of 20-25 feet in suspect soil conditions under Elm Street. Record drawings and recent project experience indicate the presence of soft clays that may require pile support or other geotechnical considerations. Survey data of the pipe profile in Elm Street indicates a noticeable sag in the pipe profile. Options A and B are more costly than Option C, but are more resilient, with Option B balancing cost with resilience. A portion of the cost difference between Options B and C is the result of uncertainty related to the subsurface conditions and the extent of geotechnical concerns. Further consideration of the uncertainty and cost ramifications is provided in Section 8 – Recommendations.

Table 7-3: Cost-Benefit Comparison (East Side of Collection System) – 2-Year Design Storm

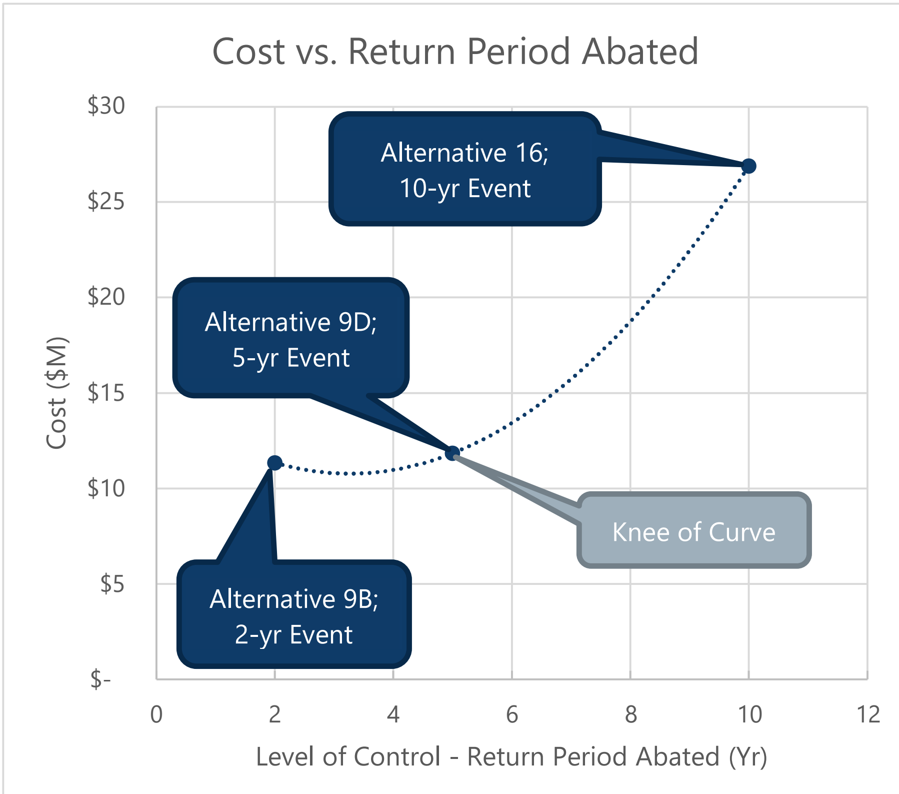
Alternative		CSO Reductions (MG)	Remaining CSO Volume (MG)	Conceptual Project Cost (2022 Dollars)	Cost per Gallon Abated (2022 Dollars)
13	Targeted Inflow Study & Separation Program	(0.30)[1]	0	$3.1M[2]	$10.33
15	Targeted Infiltration Study & Renewal Program	(0.05)[3]	0.25	$2.5M[4]	$50.00

1 – Runoff volume during design storm exceeds modelled overflow volume during design storm (0.30 MG)
2 – Assumes paving, mobilization, and other shared costs borne by roadway improvement project
3 – Based on calibrated 2018 model, groundwater contribution to overall CSO volume during design storm is low
4 – $2.5 Million distributed over 10 years; $250,000 per year

7.3 Cost Comparison for Greater Storms

Following the additional hydraulic analysis performed at the request of the Maine DEP, a basic “knee-of-the-curve” analysis was conducted to identify the appropriate level of protection. Figure 7-1 below indicates cost as a function of the design storm recurrence interval for the west side collection system.

Figure 7-1: Cost vs. Protection Analysis, West Side Collection System



The cost to achieve a 5-year control level is approximately a 7% increase over the cost for the recommended 2-year control level alternatives, reflecting an incremental change in pipe size over a limited length. The cost to achieve a 10-year control level is approximately 220% of the cost for 5-year control level, reflecting a project that is nearly three times the scope of Alternatives 9B or 9D. Combined with the uncertainty associated with larger storm events, the best balance of cost and protection of sensitive receiving waters is Alternative 9D, which eliminates overflows at the higher priority CSO #005 and CSO #006 discharges, shifting overflow to the less sensitive receiving water at CSO #024.

8. RECOMMENDATIONS

Based on the mitigation alternatives screening, analysis, and cost estimating documented in the preceding sections, a combination of inflow and infiltration reduction projects and conveyance improvement projects are recommended to reduce CSO volume, in addition to further investigation to evaluate system performance and reduce uncertainty in mitigation alternative cost. Recommendations for each side of the collection system are detailed below.

8.1 West Side of Collection System – CSO #005, #006, #024

Fourteen mitigation alternatives were evaluated for the west side of the collection system, including strategies for inflow and infiltration reduction, conveyance capacity improvements, inline storage, and offline storage. Through a combination of feasibility screening and cost-benefit analysis, large-scale inflow and infiltration reduction projects were eliminated due to a high cost per gallon of CSO abated (see Table 7-2). Offline storage alternatives were eliminated due to the necessary land acquisition, increased operations and maintenance burden and absence of aging infrastructure renewal. The best value in terms of both CSO reduction and overall system resilience is conveyance capacity improvement combined with strategic inline storage.

In consideration of the recommended alternatives in the overall context of the collection system, additional investigation actions are recommended to reduce uncertainty associated with subsurface conditions in the vicinity of Elm Street and Pearl Street. The recommended actions are summarized below.

- Alternative 7 – Raise CSO #006 Weir
- Alternative 10 – Increase Pearl Street Pump Station Capacity
- Alternative 9 – Increase Conveyance Capacity from CSO #006 to Pearl St Pump Station
    - Conduct subsurface geotechnical investigation along all options to verify geotechnical cost considerations.
    - Pursue Alternative 9D or equivalent capacity to eliminate overflow at CSO #005 and CSO #006 during the 5-year design storm
- Post-Implementation Verification – Metering and model update

Based on the results of the alternatives analysis, implementing these recommendations will result in no CSO volume in the west side of the collection system during the 2-year, 24-hour design event under medium groundwater conditions, and no CSO volume at CSO #005 and CSO #006 during the 5-year, 24-hour design storm.

8.2 East Side of Collection System – CSO #018

Three mitigation alternatives were evaluated for the east side of the collection system, including strategies for inflow and infiltration reduction, conveyance capacity improvements, and offline storage. Through a combination of feasibility screening and cost-benefit analysis, offline storage alternatives were eliminated due to the necessary land acquisition, increased operations and maintenance burden and absence of aging infrastructure renewal. Furthermore, as a result of recent capacity increases and ongoing separation projects, the east side of the collection system has demonstrated 25-year return period level protection from overflows. The best value in terms of continued CSO protection and overall system resilience lies in targeted lining. These alternatives will be accomplished through continued lining based on results of condition assessment. The recommended actions are summarized below.

- Alternative 15 – Targeted Infiltration Study & Renewal Program
- Post-Implementation Verification – Metering and additional modeling from Front Street Pump Station to the WWTF and the CSO #018 tributary area

Alternative 15 is anticipated to occur over the course of the 10-year implementation period, addressing pipes exhibiting the greatest deterioration first and proceeding in accordance with priority. Implementing these recommendations will result in less sensitivity to groundwater conditions and less wet weather flow to the WWTF. The Post-Implementation Verification study will occur in years 9 and 10 of the implementation period.

8.3 Financial Capability Assessment

To understand the financial burden of the recommended abatement alternatives, a Financial Capability Assessment (FCA) was conducted in accordance with the 1997 Environmental Protection Agency (EPA) "Combined Sewer Overflows – Guidance for Financial Capability Assessment and Schedule Development," which presents a two-phase approach to assess a permittee's financial capacity to implement the recommended CSO abatement alternatives.

First, the Residential Indicator measures the financial impact of the current and proposed wastewater and CSO abatement costs on the residential users as either "low," "mid-range," or "high." Utilizing the costs associated with the recommended CSO abatement projects along with the City's Water Resource Protection Department's FY23 operations and maintenance budget and its Capital Improvement Plan budgets for FY23 through FY29, the financial impact to residential users was calculated as "mid-range." The Residential Indicator calculations are included in Worksheets 1 and 2 in Appendix F. At this time, the Water Resource Protection Department's Capital Improvement Plan budget does not include any additional costs that may be necessary to comply with the forthcoming waste discharge license. Any additional upgrades to the WWTF as the result of the new license requirements would increase the financial impact to residential users.

Secondly, financial indicators such as debt, socioeconomic and financial conditions are determined to identify the City's Financial Capability Indicator as either "weak," "mid-range," or "strong." Utilizing the information in the City's "Annual Comprehensive Financial Report for Fiscal Year Ended June 30, 2021," in addition to unemployment data from the Maine Center for Workforce Research and Information and household median income data from the US Census, the City's Financial Capability Indicator was calculated to be "strong". The Financial Capability Indicator calculations are included in Worksheets 3 through 9 in Appendix F.

Finally, the Residential Indicator and the Financial Capability Indicator scores are combined in the Financial Capability Matrix to determine the permittee's overall financial capability and help determine an appropriate schedule for implementing the recommended CSO abatement alternatives. The matrix determined that the financial impact to the City would be considered "low burden" resulting from the recommended CSO abatement costs. The Financial Capability Matrix calculation is included as Worksheet 10 in Appendix F.

The "low burden" results of the FCA indicate that the proposed CSO abatement projects should be implemented based on "normal engineering and construction schedule" However, given that several of the proposed CSO abatement alternatives are dependent on upstream or downstream improvements before control levels will be achieved, the proposed implementation schedule must sequence the recommended alternatives appropriately. Additionally, given the economic climate at the time of this CSO Facility Plan update consists of rising material costs, supply issues, and labor shortages, it is anticipated the implementation of large-scale construction projects over the next two to three years will take longer than previously experienced for similar type projects. These factors were considered in the development of the proposed implementation schedule outlined in Section 9.

9. IMPLEMENTATION SCHEDULE AND BUDGET

The recommended alternatives and additional actions are anticipated to be carried out over the course of a 10-year implementation period. On the west side of the collection system, projects are scheduled to start from the downstream-most improvement (Pearl Street Pump Station) and work upstream, increasing conveyance from CSO #006, and ultimately evaluating the effectiveness of the implemented alternatives. On the east side of the collection system, projects are scheduled to start with the currently active separation project, implementing subsequent separation projects in conjunction with scheduled roadway projects, systematically lining collection pipes with the most severe defects, and ultimately evaluating the effectiveness of the implemented alternatives. Table 9-1 shows the proposed overall implementation schedule.

The actions recommended in this implementation plan constitute a significant investment in eliminating CSO volume during the 2-year, 24-hour design storm in compliance with the City of South Portland's Clean Water Act regulatory requirements outlined in Section 1. Recommended alternatives also target the Maine DEP directive to provide additional protection to sensitive receiving waters, eliminating overflows at CSO #005 and CSO #006 during the 5-year design storm. South Portland has made significant progress in the past 27 years in reducing the number of overflow events and the total annual overflow volume. As the CSO volume to be abated becomes closer to zero, the incremental cost of CSO reduction rises steeply, and it becomes increasingly important for CSO abatement projects to renew aging infrastructure and improve existing assets wherever practical to provide multiple benefits. This plan sets a path for significant progress in CSO reduction and overall system resilience over the next 10-year period.

Table 9-1: 10-Year Implementation Schedule

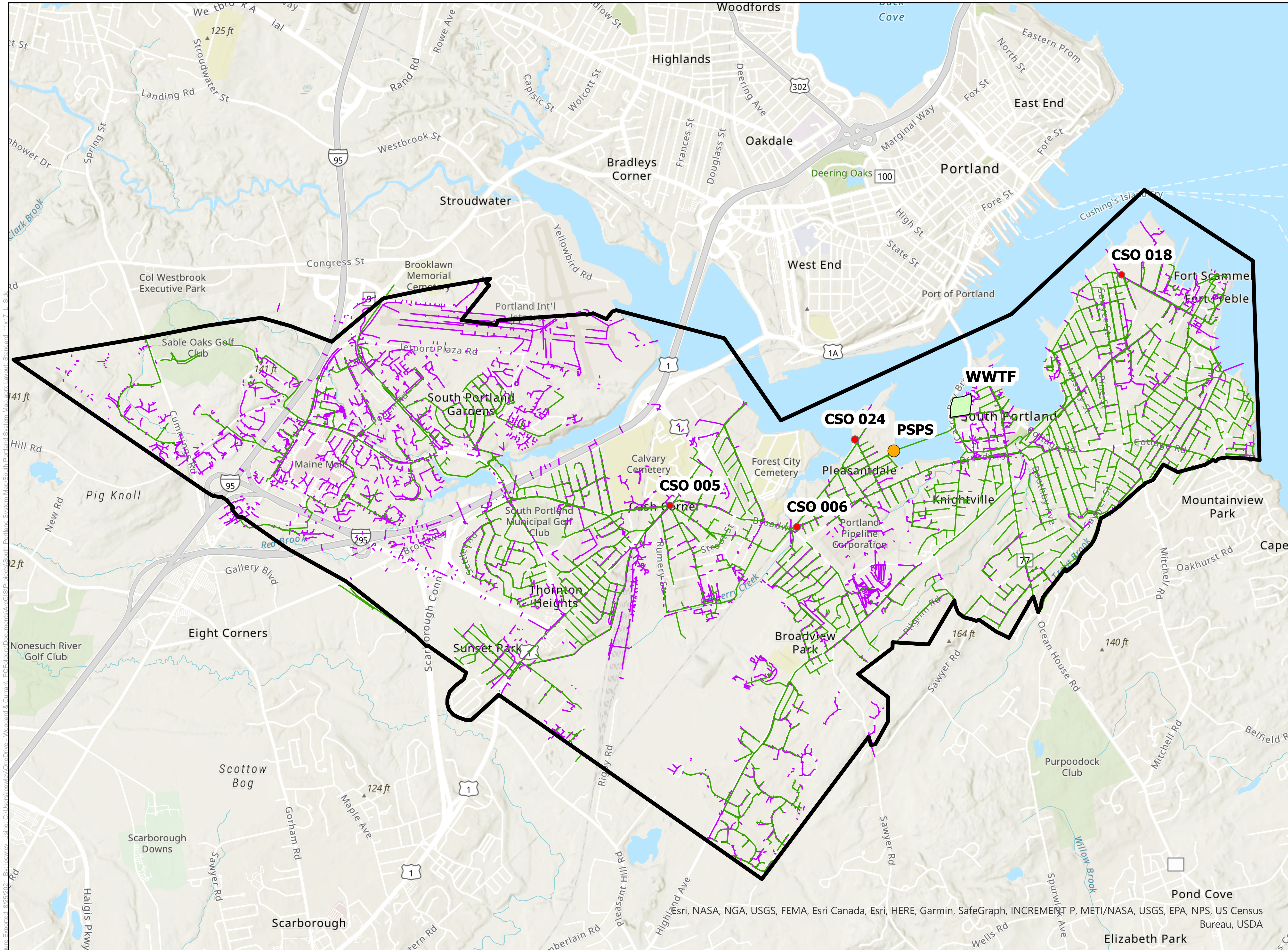
Projects	Implementation Year											Estimated Project Cost with Escalation[2]
	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	
Meetinghouse Hill Separation[1]	Construction											$2,800,000
Alternative 10 - Increase Pearl Street Pump Station Capacity	Design		Construction									$15,900,000
Alternative 7 - Raise CSO #006 Weir												$53,000
Alternative 15 - Targeted Infiltration Study & Renewal Program	$250,000 per year											$2,500,000
Alternative 9 – Increase Conveyance Capacity from CSO #006 to Pearl St Pump Station						Design		Construction				$14,900,000[3]
Post-Implementation Verification (CSO #005, #006 and #024)												$400,000
Post-Implementation Verification (CSO #018)												$275,000
											TOTAL	**$36,468,000**

1 – Project recently completed. Contract amount includes peripheral sidewalk work in addition to CSO abatement.

2 – Estimated costs include 6.0% escalation for the year 2023 and 4.0% escalation per year thereafter.

3 – Cost estimate includes geotechnical uncertainty. Subsurface investigation of all options is recommended prior to design.

APPENDIX A: FIGURES



Collection System Map

South Portland, Maine
Facilities Plan Update

N

Legend

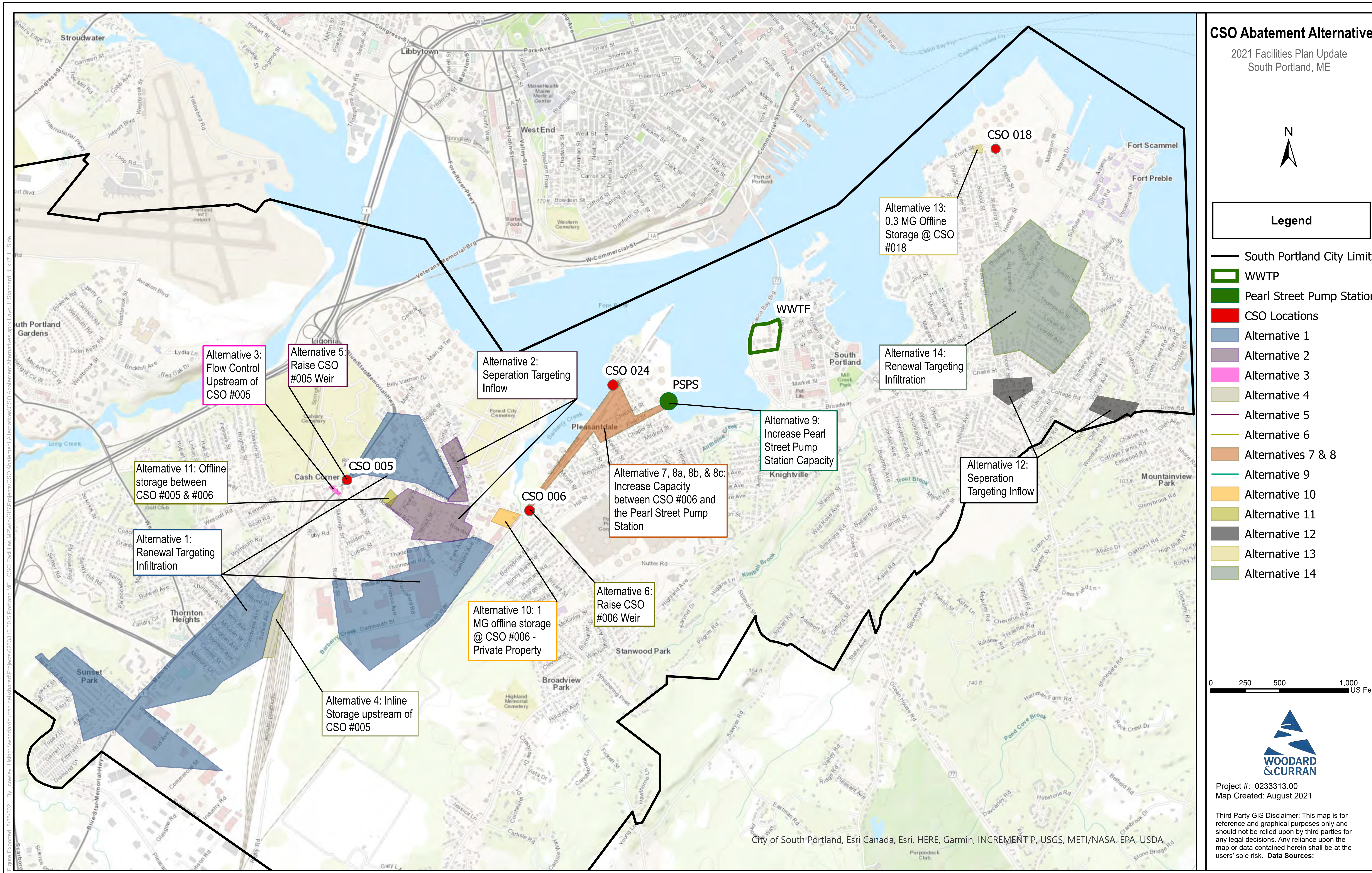
- Wastewater Pipes
- Drainage Pipes
- WWTP
- South Portland City Limits
- CSO Locations
- Pearl Street Pump Station

0 250 500 1,000 US Feet

WOODARD & CURRAN

Project #: 0233313.00
Map Created: June 2021

Third Party GIS Disclaimer: This map is for reference and graphical purposes only and should not be relied upon by third parties for any legal decisions. Any reliance upon the map or data contained herein shall be at the users' sole risk. **Data Sources:**


CSO Abatement Alternatives
2021 Facilities Plan Update
South Portland, ME
N
Legend
South Portland City Limits
WWTP
Pearl Street Pump Station
CSO Locations
Alternative 1
Alternative 2
Alternative 3
Alternative 4
Alternative 5
Alternative 6
Alternatives 7 & 8
Alternative 9
Alternative 10
Alternative 11
Alternative 12
Alternative 13
Alternative 14
0 250 500 1,000 US Feet
WOODARD & CURRAN
Project #: 0233313.00
Map Created: August 2021
Third Party GIS Disclaimer: This map is for reference and graphical purposes only and should not be relied upon by third parties for any legal decisions. Any reliance upon the map or data contained herein shall be at the users' sole risk. Data Sources:
City of South Portland, Esri Canada, Esri, HERE, Garmin, INCREMENT P, USGS, METI/NASA, EPA, USDA
CSO 018
Alternative 13: 0.3 MG Offline Storage @ CSO #018
WWTF
Alternative 14: Renewal Targeting Infiltration
CSO 024
PSPS
Alternative 9: Increase Pearl Street Pump Station Capacity
Alternative 12: Seperation Targeting Inflow
Alternative 2: Seperation Targeting Inflow
Alternative 3: Flow Control Upstream of CSO #005
Alternative 5: Raise CSO #005 Weir
CSO 005
CSO 006
Alternative 11: Offline storage between CSO #005 & #006
Alternative 7, 8a, 8b, & 8c: Increase Capacity between CSO #006 and the Pearl Street Pump Station
Alternative 1: Renewal Targeting Infiltration
Alternative 6: Raise CSO #006 Weir
Alternative 10: 1 MG offline storage @ CSO #006 - Private Property
Alternative 4: Inline Storage upstream of CSO #005
South Portland
Fort Scammel
Fort Preble
Stroudwater
Libbytown
West End
Pleasantdale
Knightville
Cash Corner
Thornton Heights
Sunset Park
Stanwood Park
Broadview Park
Mountainview Park
Ligonia

APPENDIX B: MODEL CALIBRATION MEMORANDUM

Appendix B

City of South Portland, Storm Water Management Model (SWMM) Update

1.0 Background

The purpose of this Appendix is to summarize the Storm Water Management Model (SWMM) update performed in support of the Facilities Plan Update 2021. This Appendix will address the following items related to the SWMM update:

- Hydrologic Model Updates;
- Hydraulic Model Updates;
- Model Calibration; and
- Baseline Condition

This Appendix will focus on the modifications and updates performed since 2019. The advanced modeling software PCSWMM by Computational Hydraulics International (CHI) was used during the SWMM model update. This memorandum summarizes the results of a re-assessment and calibration of the City of South Portland's SWMM modeling for the collection system tributary to the Pearl Street Pump Station including the upstream combined sewer overflow (CSO) outfalls CSO 024 at Elm Street, CSO 006 at Broadway/Evans and CSO 005 at Cash Corner.

Recent modeling is based on flow data collected in March-April 2020, following the completion of the 2019 model calibration. This memorandum provides a brief background discussion of past modeling assumptions related to groundwater and the identified issues; a discussion of the current model calibration; and a discussion of groundwater impacts from the 2020 calibration.

2.0 Hydrologic / Hydraulic Model

2019 Skeleton Model and 2012 Wright Pierce Model

In 2019 the City engaged Sebago Technics and AECOM to update the 2012 model to reflect the completed separation work with the goal of assessing its impact and to re-evaluate the alternatives for CSO abatement outlined in the Facility Plan (also considered to be a CSO long-term control plan or LTCP), expecting that the separation work would reduce the predicted CSO storage volume required. This is referred to as the "2019 Model" (see Figure 2-1).

The initial approach for the 2019 modeling effort was to:

- Update the 2012 model's collection system and RTK parameters to reflect the sewer separation work completed from 2014 to 2019 (creating the "2019 model").
- Calibrate the 2019 model against the 2018 meter data, while continuing to use the RTK methodology, consistent with the original 2012 model.
- Run the 2012 model with updated software to replicate and validate the 2012 model results compared to reports published in the 2013 LTCP update;
- Evaluate the effectiveness of completed sewer separation projects by running the design storms in the 2012 and 2019 models and comparing results.

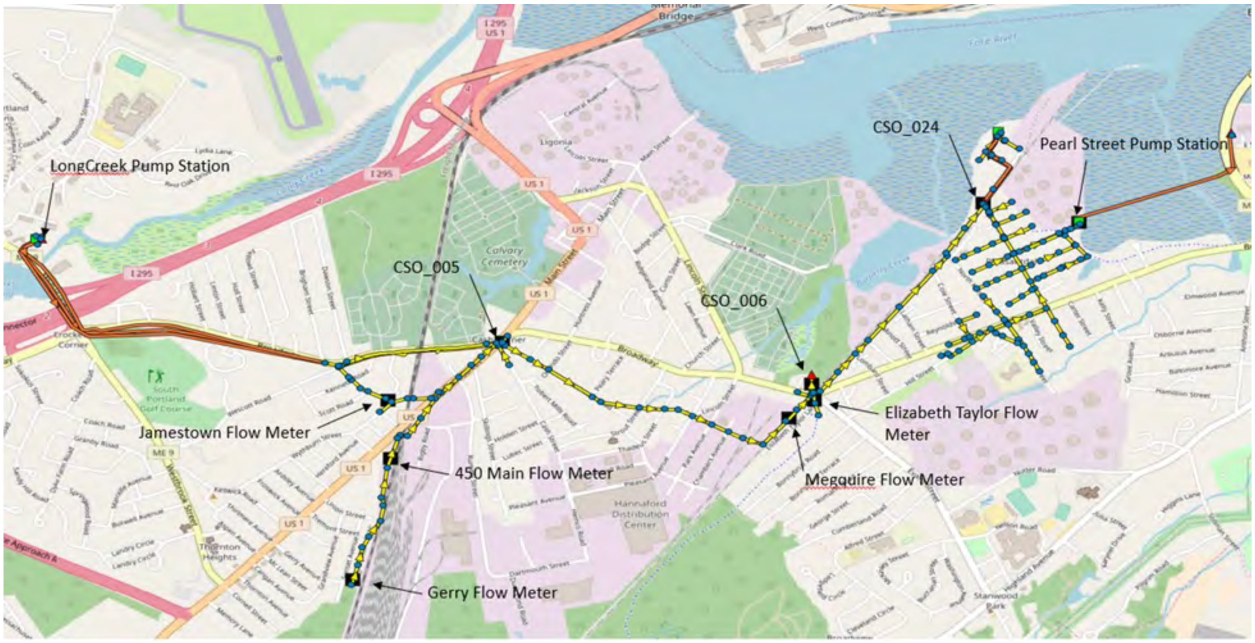


Figure 2-1. SWMM Skeleton Model and Meter Locations

Meter data for 2018 were selected for the evaluation to capture the separation work completed upstream of CSO 005 and CSO 006 and the ongoing work tributary to CSO 024 and the Pearl Street Pump Station.

As the evaluation proceeded, the following two key issues were identified.

- The 2012 model did not replicate results published in the 2012 and 2013 LCTP reports and the model was not accurately reproducing meter data when run in a long-term simulation.
- Although the City added several meter locations since the 2012 analysis, large areas of the collection area remained un-metered. A review of the meter data and CSO occurrences from 2012 through 2018 indicated a more significant groundwater influence on system flows than past modeling assumed, specifically during two observed early spring events in 2018 (April 16 and April 26).

After several attempts to replicate published 2012 model results and to calibrate the 2012 and 2019 model, it was determined that the observed groundwater impacts could not be accounted for using the RTK methodology employed in the 2012 model. Groundwater cannot be directly simulated using the RTK methodology.

For these reasons, a 2019 skeleton/groundwater model of the collection system was prepared which includes the key components of the system, including the CSOs, the main interceptors, and the Pearl Street pump station. The 2019 skeleton/groundwater model was extended to include all conduits with available flow meter data and the SWMM non-linear groundwater routines were applied.

An initial analysis attempted to apply a single set of groundwater parameters to allow long-term simulation of the period from March 31, 2018 to October 15, 2018. The late March to mid-October period was selected to avoid periods of snow and frozen ground conditions and to capture spring conditions. Both snowmelt and frozen ground conditions are quite challenging to simulate with a collection system model. Additionally, the late March to mid-October period encompasses the summer recreational season, which should be of most concern to Maine Department of Environmental Protection (MEDEP) and to broader stakeholders, with respect to human health risks associated with water quality.

The results indicated that groundwater conditions in the spring and late fall were notably different than in summer and early fall such that a single set of parameters could not be applied to simulate both time periods. Therefore, two model versions were calibrated:

- A medium groundwater condition was assumed and calibrated to September 2018 meter data. This medium groundwater model version reasonably matches September 2018 meter data but underpredicts observed spring overflows.
- A high groundwater condition was assumed and calibrated to April 2018 meter data. This high groundwater model version reasonably matches April 2018 meter data and simulates spring conditions, but over predicts flows during low groundwater seasons.

Simulating the 2-year, 24-hour design storm with both the moderate and high groundwater model versions produces notably different overflow volumes. The observation that groundwater has such a pronounced impact on overflow volumes in the South Portland system suggests that it would be reasonable to re-assess inflow control options as an alternative to off-line storage as recommended in the 2012 CSO Facility Plan, which was based on the 2012 Model.

The City's 2011 CSO Facility Plan, updated in 2013 and alternatively referred to as the Long-Term Control Plan (LTCP), established a 2-year, 24-hour storm as the design storm for sizing CSO abatement at CSO 005, CSO 006 and CSO 024.

The modeling supporting selection of the 2-year design storm as the basis for the level of CSO control was performed by Wright Pierce Engineers in 2012 (2012 model) and used the RTK method to predict rainfall derived inflow and infiltration in the system (RDII). In the 2012 model, groundwater was assumed to be a nominal component of the total flow and was assumed to be a constant flow rate and a part of the dry weather flow (DWF). The 2012 model was calibrated by adjusting RTK parameters based on flows observed in an April 28, 2008 storm event and produced reasonable results for that event.

The design storm applied in the 2012 model was a 2-year, 24-hr storm with an SCS Type III distribution and corresponding rainfall intensities. Based on the 2012 model, the City completed a series of CSO separation projects in 2013-2018 and deployed depth and flow meters in the system collecting data between 2012 and 2019, to evaluate the impact of the sewer separation projects on CSOs.

Survey

Various discrepancies were identified during the 2019 model calibration. These included discrepancies between the model and the flow metering schematics sheets, and between regulator structure drawings/modifications. Accordingly, part of the work completed for the calibration was updating the base plan survey. Sebago Technics Inc. (STI)I worked with the City of South Portland to complete manhole and regulator structure surveys to confirm pipe sizes, pipe inverts, and CSO regulator structure dimensions. This information was compared to the flow meter sketches provided and if there was a conflict, STI completed a second field visit to verify the correct dimension. Figure 2-2 shows the regulator sketch provided for CSO 005. Regulator sketches provided for CSO 006 and CSO 024 are included in Attachment A.

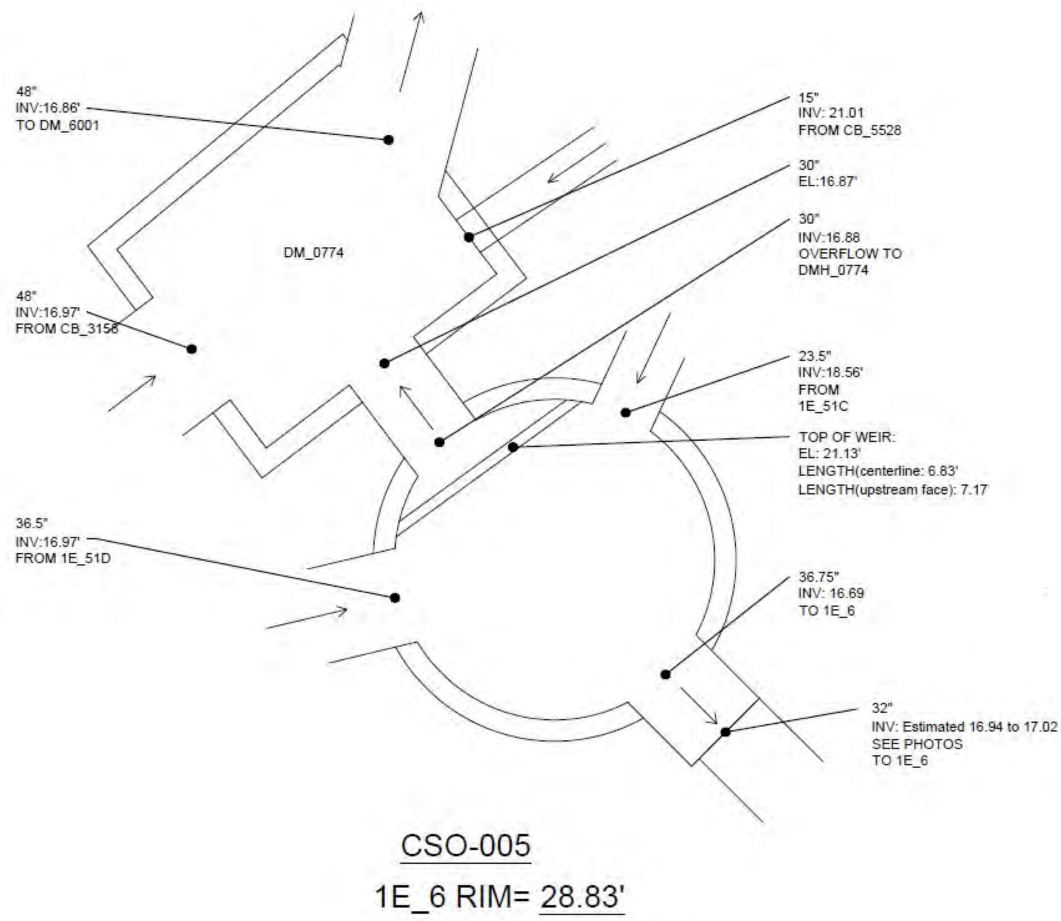


Figure 2-2. CSO 005 Sketch

The updated survey information was provided, and the model was reviewed. In the majority of the locations, the survey and the model reflected the same information. In a few instances, there were minor conflicts and those were resolved by changing the model to reflect the updated survey. Comparisons of information provided by the regulator sketches and included in the updated SWMM model are included in Attachment B.

Model Updates 2020

The SWMM hydraulic network consists of conduits, nodes, storage, pump stations, controls (e.g., gates), weirs, orifices, and outfalls. This section summarizes the major changes made to the hydraulic model during the model update.

Several model updates were undertaken prior to model calibration. The 2019 skeleton model was combined with portions of the 2012 Wright Pierce model and then was updated based on the metering location schematics and sketches provided by the City. This version of the model is referred to as the 2020 model. The 2020 model includes the major sewers, pump stations, and upstream interconnections. The combined subcatchment delineations are shown in Figure 2-3. This combining of models resulted in two different methodologies within the model to handle wet weather flow:

- The areas tributary to pump stations PS3, PS8, PS9, PS10, PS11, PS21, PS23, and PS30 utilized the RTK method. The flows from these areas were reviewed and appeared reasonable. Since data were not available for adjusting these areas were not changed as part of the model update.

- The areas downstream used the Groundwater Module in the software to simulate the slow acting groundwater inflow response and the Runoff Module was used to simulate the fast acting response.

The model network (pipe sizes and connectivity) was also updated based on the survey data gathered by STI and based on the flow metering schematics provided by Flow Assessment.

The model utilized a routing time step of 10 seconds, which with the variable timestep option maintained an appropriate level of model stability.

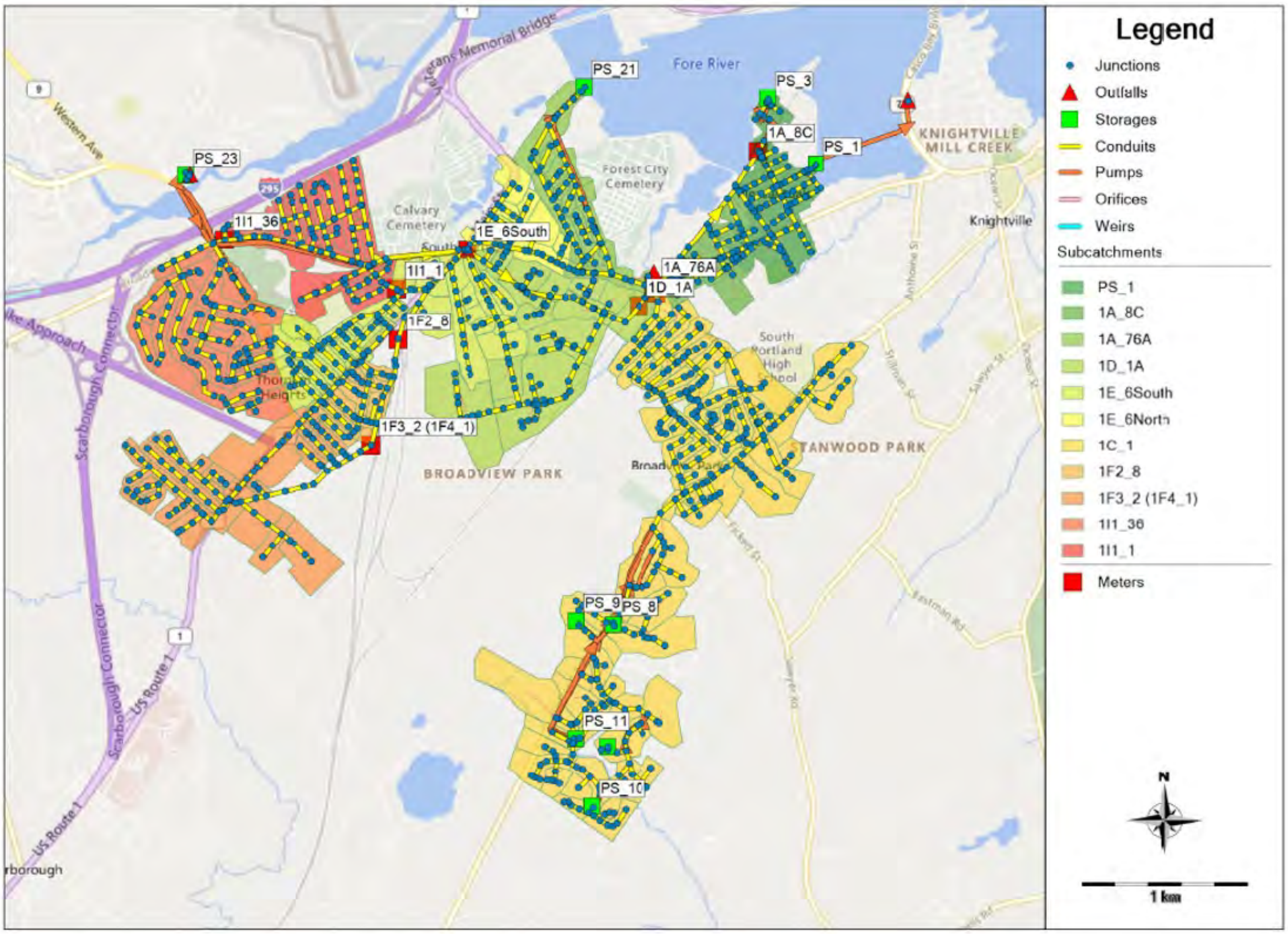


Figure 2-3. Updated SWMM Model

3.0 Monitoring Data

During the 2020 model calibration, flow monitoring data were collected during March and April 2020. In addition to the flow monitoring program, additional data are necessary to complete the collection system calibration, including:

- Rainfall;
- Groundwater level data;
- SCADA Pump Station data; and
- CSO regulator data.

Each of these parameters is summarized below for the 2020 model calibration.

Rainfall

The rainfall data used to run the models were provided by Flow Assessment in 5-minute increments as part of the monitoring program. A summary of the calibration events used in the updated calibration is presented in Section 4.

A total of seven events were analyzed in the time period of March 25 to April 28, 2020, with an inter-event time period of 12 hours. A total of 5.97 inches of rainfall was recorded during this time period. IDF curves were developed based on NOAA Atlas 14 precipitation frequency estimates for South Portland, Maine. It was determined that all the storms during the time period had a storm recurrence interval of less than one year. Figure 3-1 shows a plot of rainfall, including all seven storms and Table 3-1 summarizes the total rainfall of the seven storms. Peak intensities are based on 5-minute intervals.

Figure 3-1. Rainfall Plot of Seven Storms from March 25 to April 28, 2020

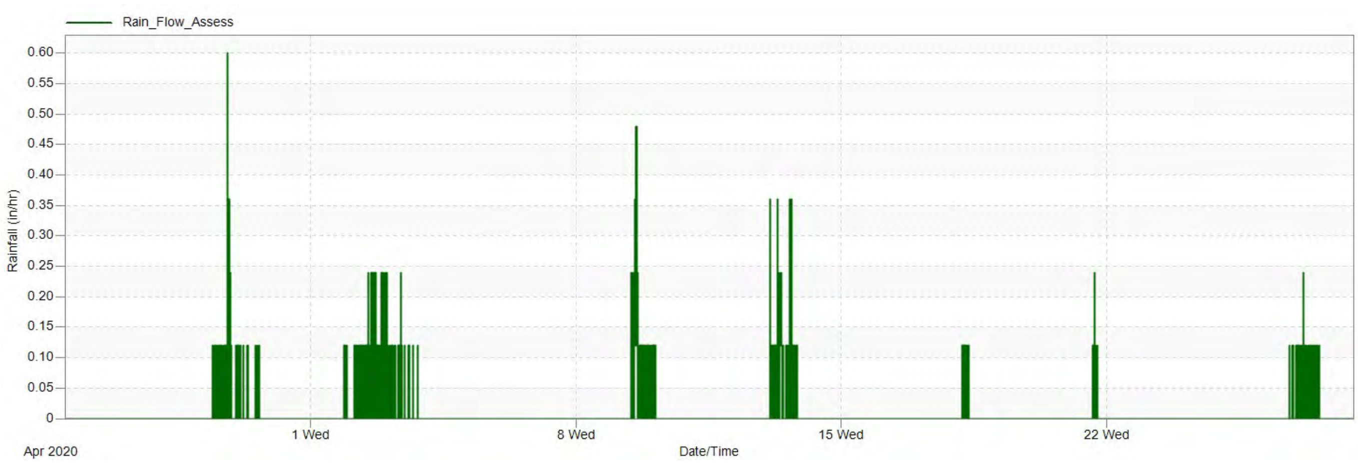


Table 3-1. Total Rainfall of Storms

Event	Date	Duration (h)	Peak Intensity (in/h)	Total Rainfall (in)
1	Mar 29, 2020 10:00 AM	29.42	0.60	0.96
2	Apr 01, 2020 9:20 PM	46.67	0.24	1.64
3	Apr 09, 2020 10:50 AM	15.25	0.48	1.36
4	Apr 13, 2020 2:55 AM	16.92	0.36	1.13
5	Apr 18, 2020 4:55 AM	3.58	0.12	0.11

Event	Date	Duration (h)	Peak Intensity (in/h)	Total Rainfall (in)
6	Apr 21, 2020 3:25 PM	3.00	0.24	0.15
7	Apr 26, 2020 7:45 PM	19.33	0.24	0.62

Flow Assessment Flow Data

Model calibration was based on the flow metering program completed in 2020 by Flow Assessment, as well as working with the existing model calibrations completed by AECOM in 2019 and Wright Pierce in 2012. Due to the level of detail associated with the dry weather calibration completed in 2012, the dry weather flow calibrations were minimally adjusted for the subcatchments. The focus of the 2020 model update was wet weather calibration and replacing the RTK parameters with the Groundwater Module based on flow metering data.

Flow metering of the collection system was conducted for the purpose of development and calibration of the collection system model. In addition, flow data established: which areas of the City contribute relatively more or less flow; where infiltration and inflow may be disproportionately high; and how and where the timing of peak flows may contribute to CSO events.

A flow monitoring plan was developed by Sebago Technics, Inc. in the winter of 2020 and implemented by Flow Assessment in the spring of 2020. Spring is typically a high groundwater period. The spring is typically when the City of South Portland will see freeze-out conditions (ground thawing), with snowmelt and spring rains. Due to the rather unusually warm March and drought-conditions experienced in the winter and early spring of 2020, the typical freeze-out conditions were not experienced. However, during the flow monitoring period (approximately 1 month), the City experienced about 6 inches of rain, meaning the period was relatively wet.

Flow data were collected at multiple points in the collection system and over a range of weather conditions, including spring storm events and periods of dry weather.

The meters and locations are listed in Table 3-2 and shown on Figure 3-2. Including the flow meters at the Pearl Street and Long Creek Pump Stations, data from a total of twelve flow meters were available for model calibration. Table 3-2 presents the following information for the metering periods:

- Meter name.
- Model node/pump. This is the node (manhole or similar structure) or pump in the model where the meter was located.
- Meter location.

. Figure 3-2 shows a schematic representation of how the flow meters are interconnected.

Table 3-2. Flow Metering Program

Meter Name	Model Node/Pump	Location
PS_23	LONGCREEK2	Long Creek Pump Station
1I1_36	1I1_36	Broadway near Westbrook St
1I1_1	1I1_1	Jamestown Court R.O.W.
1F3_2 (1F4_1)	1F3_2	Gerry Ave R.O.W.
1F2_8	1F2_8	450 Main St R.O.W.
1E_6South	1E_6	300 Main St
1E_6North	1E_6	300 Main St
1D_1A	1D_1A	1 Wallace Avenue R.O.W. (in steel yard)
1A_76A	1A_76A	Broadway at Evans St
1C_1	1C_1	15 Evans St
1A_8C	1A_8C	75 Elm St
PS_1	PS_1-TR_1_STORM	Pearl St Pump Station

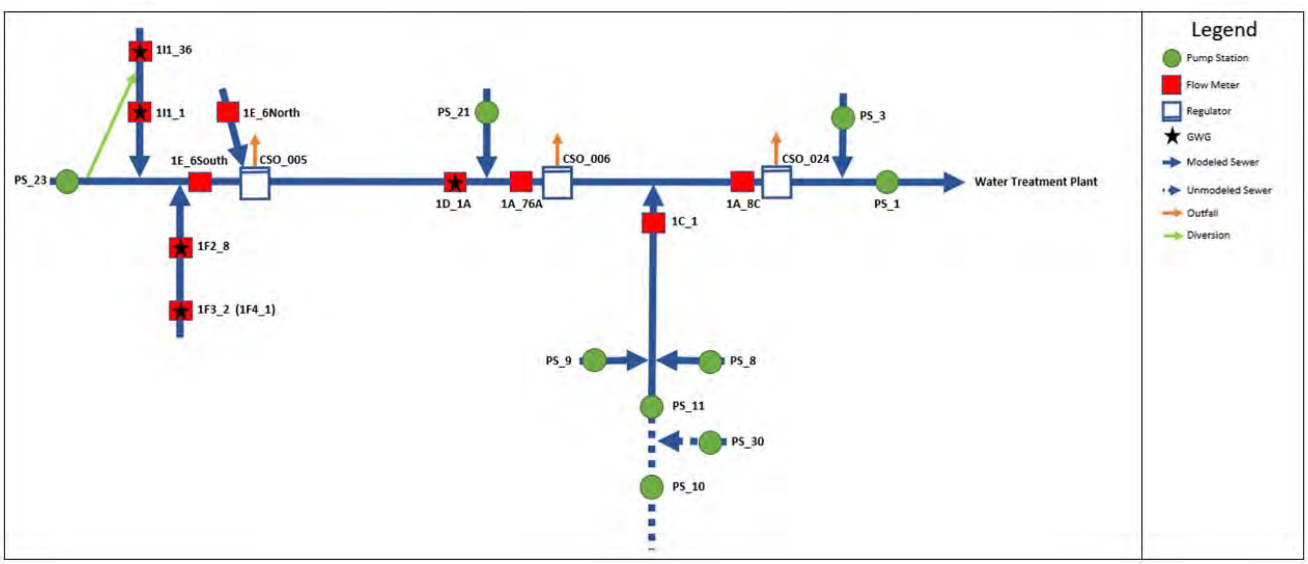


Figure 3-2. Flow Meter Schematic

In addition to the flow metering program, other data sources included metering data at the Pearl Street Pump Station, the Long Creek Pump Station, and permanent CSO meters (i.e., meters used for reporting at the overflow structures) at CSO 005, CSO 006, and CSO 024.

Model parameters were adjusted to better match meter data, calibrating the model upstream first, then moving to the downstream meters.

Groundwater Level Data

Piezometers were installed at the regulators marked with a star in Figure 3-2 to assess the groundwater level. Figure 3-3 shows an example plot for the piezometer installed near meter 1I1_1. These data show that the groundwater level fluctuates during the monitoring period in response to rainfall.

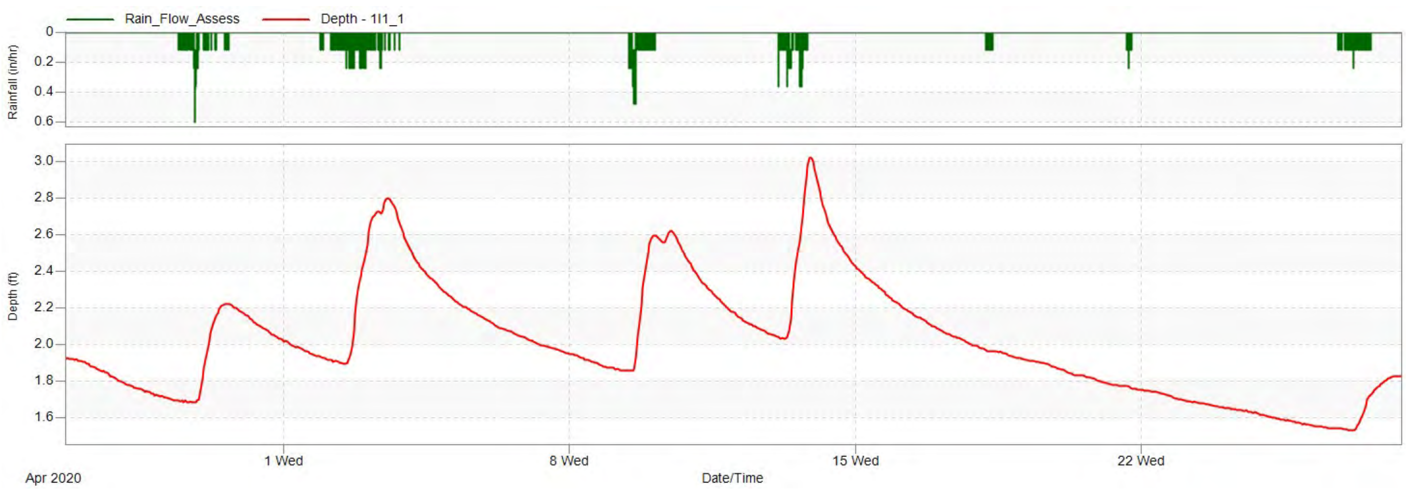


Figure 3-3. Groundwater Level for Flow Meter 1I1_1

As discussed in Section 4, the model was configured to simulate groundwater inflow using the groundwater algorithms built into the model. If the groundwater algorithms were not able to adequately simulate the groundwater inflow, then the piezometer data could have been used to establish a groundwater boundary condition. However, the groundwater algorithms in the model software were able to simulate observed groundwater inflow, and it was not necessary to utilize the piezometers for establishing groundwater boundary conditions. The piezometer data are still useful because they confirm that groundwater levels vary based on rainfall and correlate with periods of higher groundwater inflow.

SCADA Pump Station Data

SCADA pump station data were provided for Long Creek (PS_23) and Pearl St (PS_1). These data were used for model calibration.

City Level data at CSO Regulators

The regulator structure data indicated that during the flow monitoring program from March 24 through April 28, 2020, there were no CSO activations at CSO 005, CSO 006, or CSO 024. The level data at the three CSO regulators were used for model calibration.

4.0 Model Calibration

Dry Weather Calibration Adjustments

The dry weather period of April 22 through April 26, 2020 was used to determine the dry weather flows for each metering basin. The sanitary and base infiltration flows for each metering basin were estimated using the Stevens-Schutzbach equation. The 2012 model utilized a single dry weather flow value and did not differentiate between sanitary and base infiltration flows. For the refined model, the sanitary and base infiltration flows for each meter basin were proportioned to the upstream model nodes using the dry weather flow values in the 2012 model. As part of the dry weather calibration, the sanitary component of the dry weather flow is varied hourly based on weekday and weekend diurnal curves assigned. Because of Stay at Home COVID-19 restrictions, the diurnal patterns may not have been representative of most normal time periods, and therefore, diurnal patterns from the 2019 skeleton model were used.

An analysis of the flow data indicated that there was a flow imbalance between the influent meter at CSO24 (meter 1A8C) and the Pearl Street Pump Station (PS1). The upstream flow (meter 1A8C) was higher than at the downstream meter (PS1). Based on a review of the data, it was determined the upstream meter was more accurate. The calibration therefore focused on utilizing the upstream meter. This provided a better match to observed water levels, provided more realistic estimates of flow entering the meter basin, and was more conservative. As a result, it was not possible to match the flow recorded at the downstream Pearl Street Pump Station.

Wet Weather Calibration

The flow metering data indicated that the wet weather response to rainfall was predominately slow acting groundwater infiltration with some meters showing some faster responses characteristic of impervious surfaces. During the wet weather calibration process, the percentage of impervious areas and catchment width were adjusted to better correlate the model to the fast response component of the flow metering data, while the groundwater module was used to calibrate the groundwater response. Evaporation is a critical component in simulating the seasonal variation in groundwater infiltration and inflow. During the late fall, winter, and early spring, evaporation is low and groundwater levels rise, resulting in higher groundwater infiltration and inflow than in the summer, when evaporation is higher and the groundwater level is lower. Table 4-1 is a summary of the typical monthly evaporation factors that were used in the model. To achieve a better correlation with observed flows, the lower groundwater loss rate, initial groundwater level, and groundwater inflow parameters were adjusted during calibration. The percentage of impervious area and subcatchment width were adjusted to better match the fast response component of the flow meter data. Since Long Creek has no associated baseline flows, the settings of the corresponding wet wells and pumps were adjusted to better match the observed cycling of the pump. Areas upstream of the pump stations currently use the RTK methodology to simulate wet weather flows. These were not adjusted because the flow monitoring data were collected downstream from these areas and therefore there was no basis to make adjustments to the existing model.

Table 4-1. Monthly Evaporation Data for South Portland, ME

Month	Monthly Evaporation (in/day)
Jan	0.011
Feb.	0.019
March	0.035
Apr.	0.064
May	0.100
June	0.120
July	0.132
Aug.	0.114
Sept.	0.077
Oct.	0.042
Nov.	0.019
Dec.	0.011

Calibration Results

The model was run for a continuous simulation period for the 2020 metering period from March 28 to April 30, 2020.

Figure 4-1 shows the comparison of measured and modeled flow data for flow meter 1I1_1 from March 28 to April 28, 2020. Similar plots for all other flow meters are provided in Attachment C. The overall volumes for the whole period are summarized in Table 4-2. Percent errors were generally within ±10% with the exceptions of PS23, PS_1, and 1E_6North. PS23 is located upstream and cycles on and off rapidly. The model was adjusted focusing on matching the peak flows. As noted above, there was a flow imbalance discrepancy between meter PS1 and the upstream meter, and it was determined appropriate to focus on the upstream meter which had higher flow. The volume at Meter 1E6_North was over-predicted by the model. This location appears to be influenced by backwater in the interceptor which is not well simulated in the model. As the water level rises in the interceptor, likely due to the pump cycling off and on at the Long Creek Pump Station (PS23), water is stored in the upstream sewer and then released as the water level drops. The model calibration therefore focused on trying to match the peak flow, which resulted in over-predicting the volume. Table 4-3 summarizes peak flows at each flow meter for each of the five largest storms during the calibration period (storms with greater than 0.5 inches of total rainfall). The model consistently under-predicted peak flows for the April 13 storm, potentially due to rainfall phenomena not simulated by the model. Factors affecting the model calibration are described below in the Calibration Assessment.

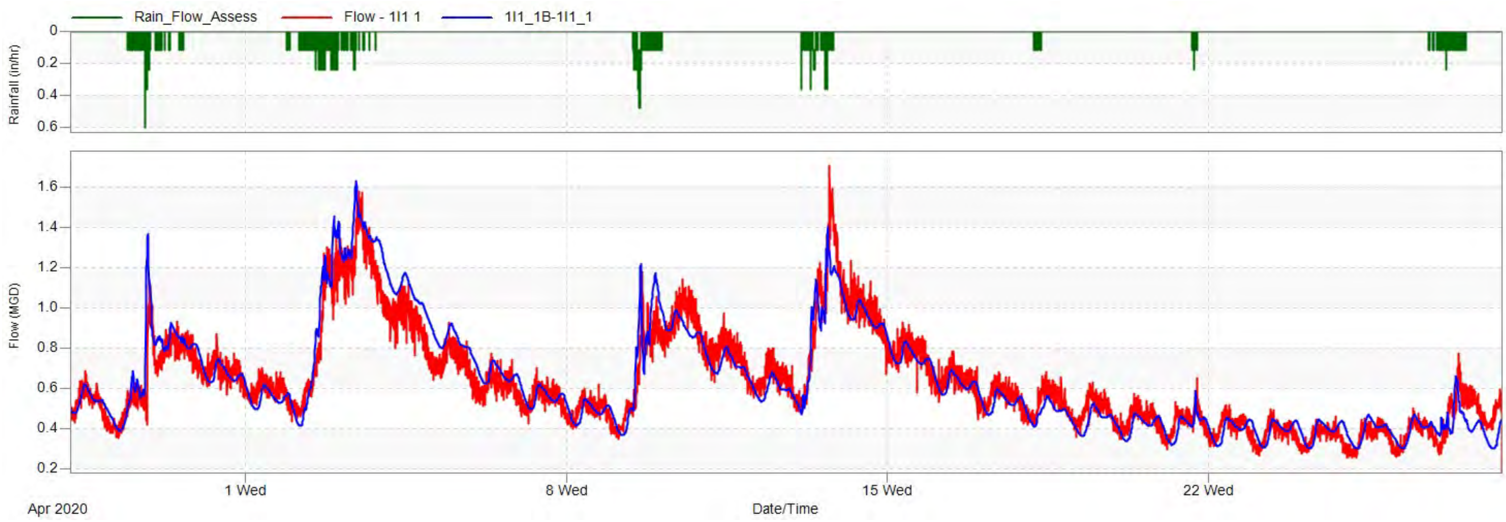


Figure 4-1. Comparison of Measured and Modeled Flow Meter 1I1_1 from March 28 to April 28, 2020

Table 4-2. Comparison of Measured and Modeled Flow Volumes from March 28 to April 28, 2020

Flow Meter	Modeled Total Flow (MG)	Measured Total Flow (MG)	Percent Error
PS_23	39.25	44.8	14.1%
1I1_36	11.32	10.97	-3.1%
1I1_1	19.91	19.77	-0.7%
1F3_2 (1F4_1)	13.79	13	-5.7%
1F2_8	14.72	13.65	-7.3%
1E_6South	77.19	78.84	2.1%
1E_6North	5.506	4.759	-13.6%
1D_1A	105.7	108	2.2%
1A_76A	114.9	113.6	-1.1%
1C_1	27.56	26.94	-2.2%
1A_8C	165	155.1	-6.0%
PS_1	169.6	148	-12.7%

Table 4-3. Comparison of Measured and Modeled Peak Flow Data from March 28 to April 28, 2020

		03/29 Storm	04/01 Storm	04/09 Storm	04/13 Storm	04/26 Storm
Storm Depth (in)		0.96	1.64	1.36	1.13	0.62
Flow Meter		**Peak Flow (MGD)**				
PS_23	**Measured**	2.67	2.76	2.66	2.72	2.66
	Modeled	2.60	2.60	2.60	2.60	2.60
	Difference	0.07	0.16	0.06	0.12	0.06
1I1_36	**Measured**	0.49	0.81	0.47	0.82	0.32
	Modeled	0.55	0.75	0.60	0.71	0.30
	Difference	-0.07	0.06	-0.13	0.11	0.03
1I1_1	**Measured**	1.14	1.58	1.18	1.71	0.77
	Modeled	1.37	1.63	1.22	1.40	0.66
	Difference	-0.23	-0.05	-0.04	0.31	0.11
1F3_2 (1F4_1)	**Measured**	0.59	0.89	0.64	0.93	0.50
	Modeled	0.57	0.87	0.70	0.82	0.32
	Difference	0.02	0.02	-0.06	0.10	0.17
1F2_8	**Measured**	0.63	0.93	0.65	0.95	0.48
	Modeled	0.60	0.90	0.74	0.86	0.37
	Difference	0.03	0.03	-0.09	0.09	0.11
1E_6South	**Measured**	3.98	6.48	4.43	5.59	3.54
	Modeled	3.85	4.56	4.25	4.55	2.98
	Difference	0.13	1.92	0.18	1.05	0.55
1E_6North	**Measured**	1.93	1.96	0.47	1.83	0.25
	Modeled	0.60	0.83	0.44	0.67	0.20
	Difference	1.32	1.13	0.03	1.16	0.05
1D_1A	**Measured**	6.34	7.49	6.75	7.56	4.41

	Modeled	7.17	7.42	6.64	6.68	4.44
	Difference	-0.83	0.08	0.11	0.88	-0.03
	Measured	7.56	8.48	8.07	9.08	4.87
1A_76A	**Modeled**	8.79	8.17	8.17	7.66	5.12
	Difference	-1.23	0.31	-0.09	1.42	-0.25
	Measured	1.25	1.74	1.22	1.88	0.89
1C_1	**Modeled**	1.26	1.69	1.45	1.57	0.87
	Difference	-0.01	0.05	-0.23	0.31	0.03
	Measured	8.22	10.00	9.29	11.83	6.30
1A_8C	**Modeled**	10.71	10.51	10.05	9.77	6.81
	Difference	-2.49	-0.51	-0.76	2.06	-0.51
	Measured	7.76	9.70	8.74	11.05	5.41
PS_1	**Modeled**	10.73	10.57	10.15	9.78	6.81
	Difference	-2.98	-0.87	-1.42	1.27	-1.40

Water level data were provided by level sensors located at CSO 005, CSO 006, and CSO 024. These data were used for estimating CSO discharges over the weirs. However, discharges over the weirs did not occur during the monitoring period. The water level data are still useful because they can confirm that the simulated water levels are corelated with the measurements. Figure 4-2 shows the comparison of measured and modeled water level for CSO 005 from March 28 to April 28, 2020. Similar plots for CSO 006 and CSO 024 are provided in Attachment F. The water levels at CSO 006 and CSO 024 matched reasonably well without any adjustments. However, the water level at CSO 005 was initially underpredicted. Figure 4-3 shows that the pipe exiting SE reduces from 36” to 32”. In order to match water levels at CSO 005 properly, sediment was added downstream and the entry loss was adjusted. Table 4-4 summarizes water levels for the five storms with rainfall greater than 0.5 inches. In general, the model predictions are within 6-inches of the measurements, with some storms higher and some lower. Factors affecting model calibration are discussed below in the Calibration Assessment.

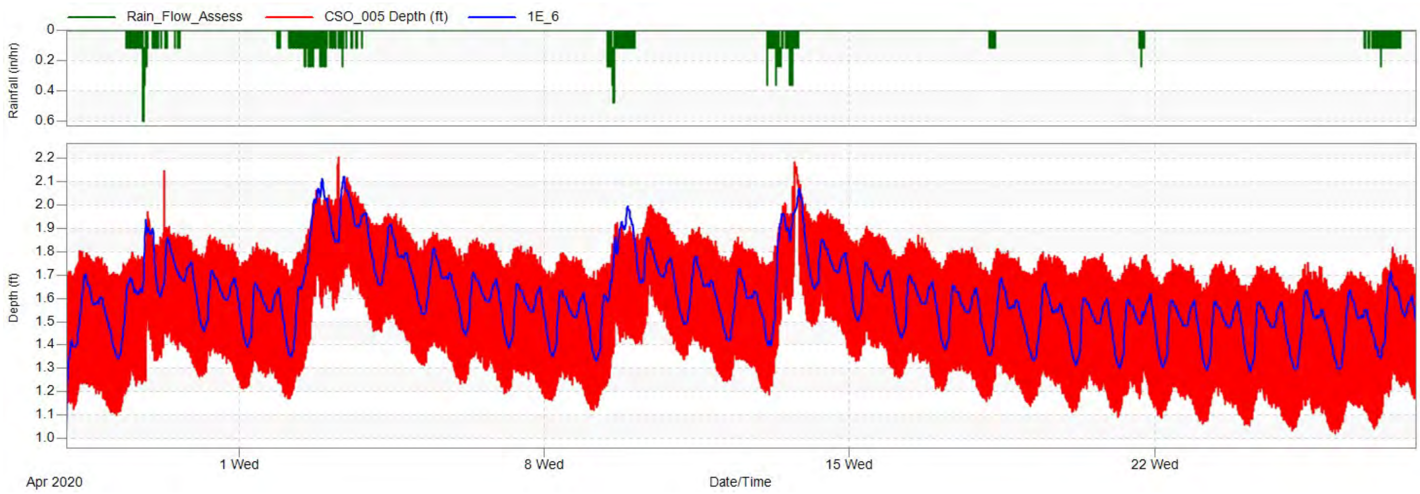


Figure 4-2. Comparison of Measured and Modeled CSO 005 Water Level from March 28 to April 28, 2020

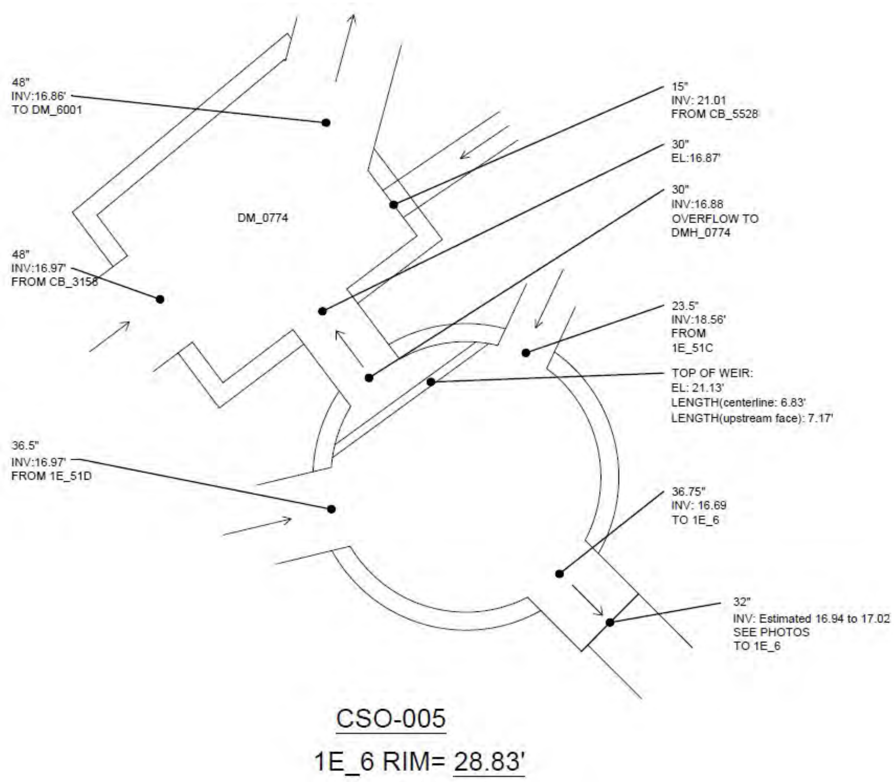


Figure 4-3. CSO 005 Pipe Size

Table 4-4. Comparison of Measured and Modeled Peak Storm Depth from March 28 to April 28, 2020

		03/29 Storm	04/01 Storm	04/09 Storm	04/13 Storm	04/26 Storm
Storm Depth (in)		0.96	1.64	1.36	1.13	0.62
Regulator		**Maximum Depth (in)**				
CSO 005	**Measured**	25.788	26.484	23.088	26.220	21.828
	Modeled	23.244	25.464	23.964	24.852	20.580
	Difference	2.54	1.02	-0.88	1.37	1.25
CSO 006	**Measured**	24.012	27.132	26.052	30.120	21.252
	Modeled	29.244	28.488	27.276	26.664	21.024
	Difference	-5.23	-1.36	-1.22	3.46	0.23
CSO 024	**Measured**	18.768	21.540	20.052	23.640	15.720
	Modeled	21.300	20.772	20.040	19.764	15.912
	Difference	-2.53	0.77	0.01	3.88	-0.19

Calibration Assessment

There are many factors that may contribute to differences between measured and simulated flows, including rainfall data quality and spatial variation, unknown transient conditions in the collection system, accuracy of metering data, and modeled approximations of hydraulic conditions in pipes and structures. In general, the model was able to replicate the storm responses for the majority of storm events in the calibration period. However, it is not possible to match all of the modeled and metered activations for every meter and storm event, nor was an exact match an expected outcome from the calibration process. The factors affecting the match between modeled and metered flows are discussed below:

- **Rainfall data quality and spatial variation**
  Spatial variation of rainfall can cause discrepancies between metered and modeled flows. Rainfall input to the model is derived from a single rain gage in the project area. The actual rainfall falling on a particular meter basin may be higher or lower. Therefore, localized rainfall variations are imperfectly captured. This is particularly relevant for thunderstorms, which can have localized bursts that may not be captured by a gage. Similarly, a localized downburst may be captured by a gage, but the rain may not have fallen on a portion of the tributary area assigned to that gage. The accuracy of the recorded rainfall at the rain gage can also be affected by factors such as wind, freezing temperatures, and frequency of rain gage maintenance.

- **Unknown transient conditions in the collection system**
  The hydraulic model is a simplification of a complex and dynamic system. While field investigations identified some previously unknown conditions, additional unknown transient conditions may exist. Sediment levels, changes in groundwater/seasonal variation, and unknown discharges into the collection system are all examples of unknown transient conditions that could impact the comparison of modeled and metered flows and water levels.

- **Accuracy of metering data**
  Each of the flow meters and water level sensors are designed to accurately measure flows. However, there may be inaccuracies in the measurements. Turbulence present in the pipes and manhole structures can interfere with recorded measurements. Sediment and fouling are other factors that can contribute to meter inaccuracies. As a result, the measurements to which model predictions are compared are subject to a certain level of uncertainty.

- **Modeled approximations of hydraulic conditions in pipes and structures**
  The model represents the main parameters that impact the flows and water levels in mechanistic fashion, i.e., by simulating the relevant phenomena based on basic, well established equations. Flows are modeled using the Saint Venant equations, which are very accurate, provided the system is correctly specified. Conduit dimensions and invert elevations have been field-verified in relevant locations, as well as sediment depths. However, the configurations of the regulators and other structures may be less than ideally configured, which can lead to simulation discrepancies. Certain complex hydraulic structures may be represented in a more simplified fashion in the SWMM software. Additionally, the hydrologic conditions which control the flow inputs to the model are simulated in detail. However, the catchments are inevitably large and all the parameters that affect flows and water levels are not individually specified. The model flows are calibrated at numerous connection points and are generally within +/- 15% of the measurements.

Flow Components

The flow in the collection system consists of dry weather flow, runoff, and groundwater inflow. The flow metering and model calibration indicated groundwater inflow is a major component of the total flow in the system. To quantify the amount of flow, the model was run with and without groundwater and runoff to estimate the components of flow at the Pearl Street Pump Station. Figure 4-4 illustrates the flow data for flow meter 1I1_1 with and without groundwater simulated. The light blue trace shows the simulated flow with dry weather flow, runoff, and groundwater, while the purple trace shows the exact same model with the groundwater component turned off. This plot shows that baseflow was higher at the start of the monitoring period and had significant groundwater inflow which diminished throughout the month of April 2020. Similar plots for all other flow meters are provided in Attachment E. Table 4-6 provides a breakdown of the flow volumes at the Pearl St pump station for the simulation period (March 28 to May 1, 2020). Groundwater makes up 17% of the total flow during the monitoring period and 80% of the wet weather flow.

Table 4-6. Flow Breakdown at Pearl St Pump Station

	Flow (MG)
Dry Weather	139.2
Groundwater	31.2
Runoff	7.9
Total	178.3

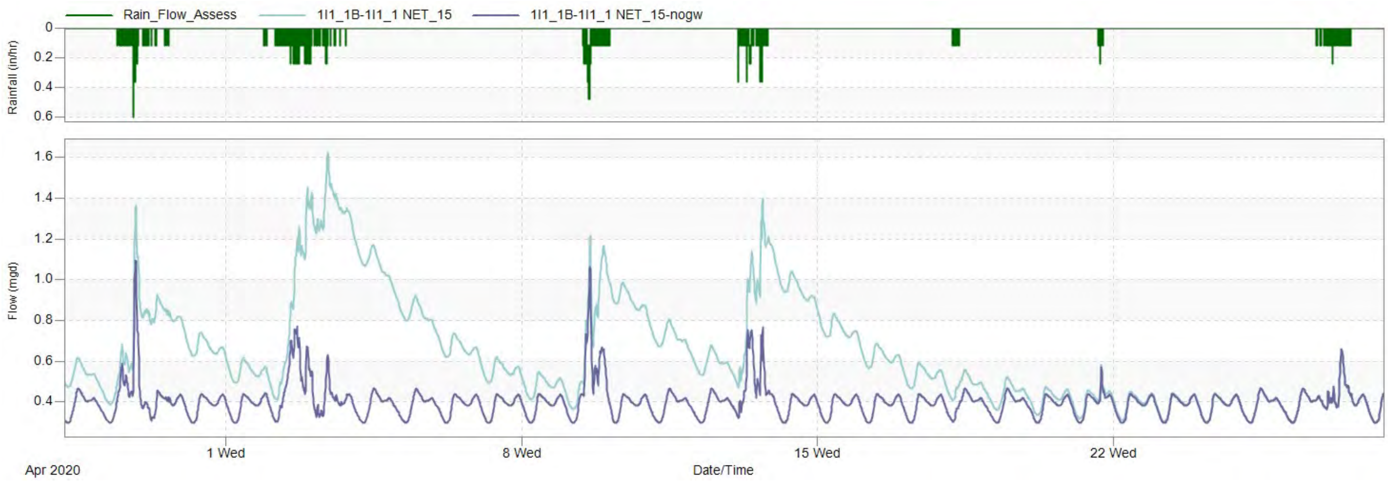


Figure 4-4. Comparison of Flow Meter 1I1_1 with and without Groundwater from March 28 to April 28, 2020

5.0 Design Storm Evaluation

The City of South Portland has committed to a CSO control to a 2-year storm event. The characteristics of the 2-year storm are summarized in Table 5-1. The 24-hour depth is based on Atlas 14 and is distributed over 24-hours using the SCS Type III distribution with 15-minute time increments. This rainfall depth is current conditions and does not include the impact of climate change. A 2-year level of control for CSOs is considered a high level of control. The updated Baseline model was run for the 2-year storm event to evaluate the magnitude of overflow for the 2-year storm. The amount of CSO is highly dependent on the antecedent groundwater conditions. A medium groundwater condition was used for the design storm. The model predicts the groundwater level drops from the initial high level on March 28 and reaches a low point at the end of April. The approximate mid-point between the high and the low groundwater level was April 23, 2020. This date was selected to represent a medium groundwater condition. The model was run for March 28 to April 23 with the 2020 rainfall to create a model “hot start” representing the conditions on April 23, 2020. The model was then run using the April 23, 2020 hot start for the 2-year design storm. This procedure results in the medium groundwater conditions being used as the initial conditions for the 2-year design storm (SCS Type III). Table 5-2 presents a comparison of the results with the previous 2019 version of the model. In general, the results are consistent and indicate that about 1 MG of CSO is predicted at CSO 6 for the 2-year storm.

Table 5-1. Characteristics of 2-year, 24-hour Design Storm Events

Recurrence Interval	Total Depth (in)	Peak 15-minute Intensity (in)
2-Year	3.23	2.08

Baseline model results for the CSOs are summarized in Table 5-2.

Table 5-2. Comparison of CSO Volume for Revised Model with Previous Models for 2-Year Storm

	AECOM Medium Groundwater (2019)	AECOM Medium Groundwater (2020)
CSO Location	**CSO Volume (Gallons)**	**CSO Volume (Gallons)**
CSO 005	0	0
CSO 006	1.28	0.99
CSO 024	0.017	0

6.0 Summary and Conclusions

The City's hydraulic model was updated to incorporate new survey data and field investigation data, and then recalibrated using flow metering at 12 locations and water level measurements at the three CSO regulators. The flow metering covered the period from March 28 to April 28, 2020. The average total rainfall for South Portland, Maine in the month of April from 1981 to 2010 is 4.32 inches (NOAA). With a total rainfall of 5.97 inches in April 2020, the quantity of rain was 38.2% more than average, therefore making this a wetter than average period.

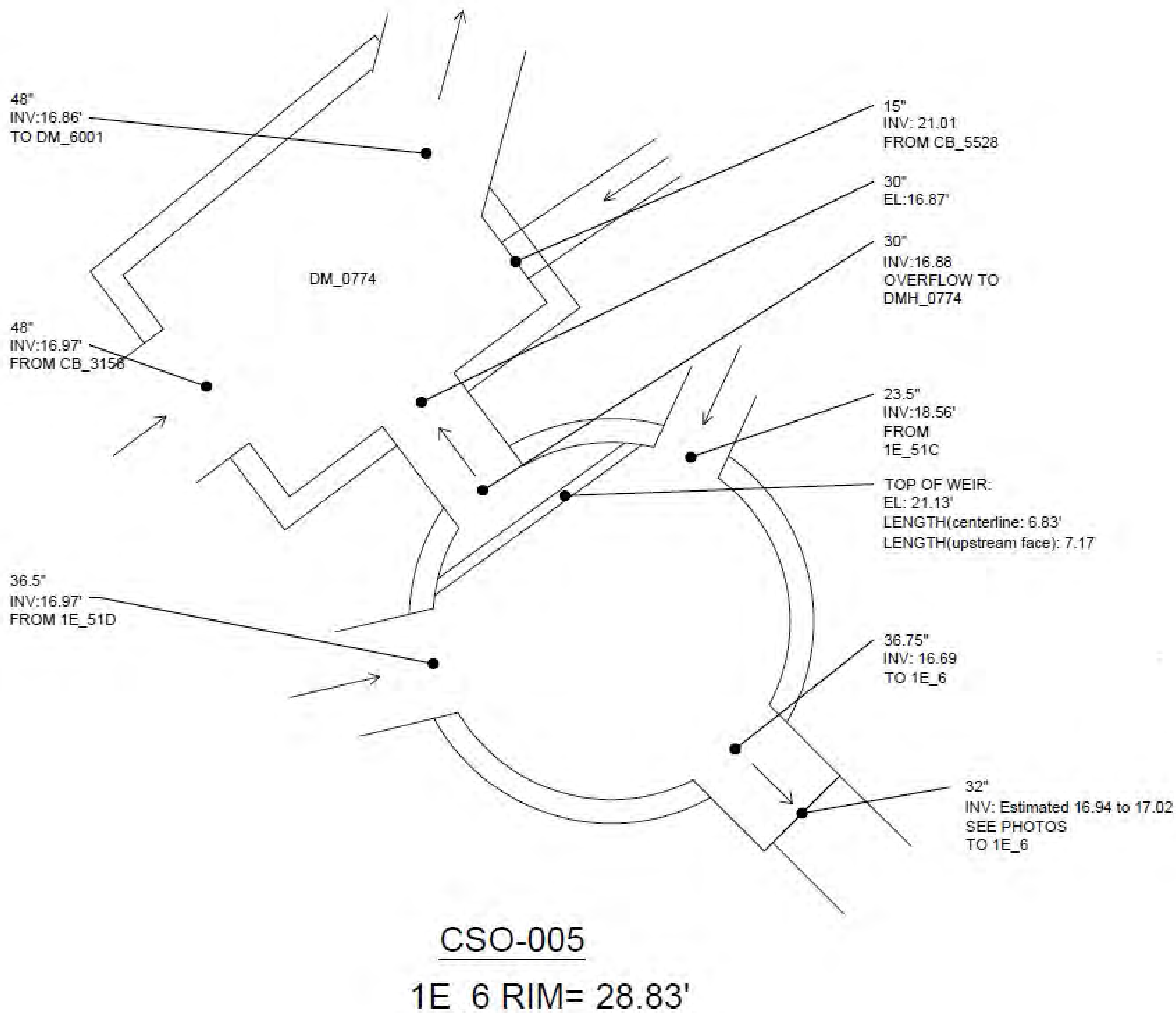
A flow discrepancy was observed between the influent meter at CSO 24 and the flow meter at the Pearl Street Pump Station. Measured pump station flows were lower than the upstream flow. The upstream flow meter was determined to be more accurate and was conservatively used for the calibration.

The flow metering data indicate that significant groundwater inflow was occurring, and therefore the groundwater component of the SWMM software was appropriately used to simulate groundwater inflow. The calibrated model reasonably simulates groundwater inflow and the observed flows and water levels. An analysis of the flow components at the Pearl Street Pump Station for the calibration period indicates that groundwater represented 17 percent of the total dry weather flow reaching the pump station and 80 percent of the wet weather flow.

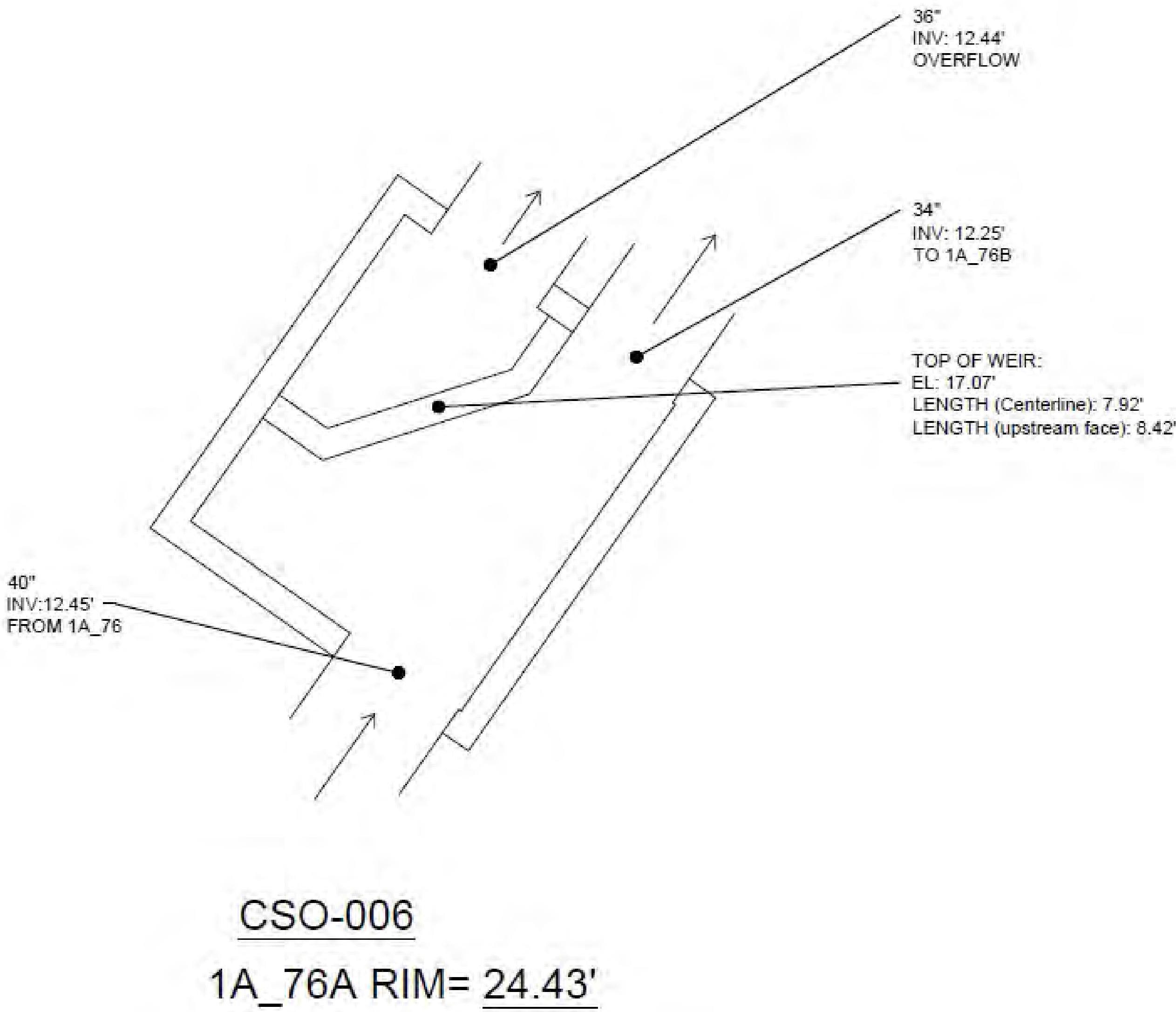
The model was applied to estimate CSO volume during a 2-year storm for a medium groundwater condition. The results indicate that about 1 MG of CSO would occur at CSO 6 and no overflows at CSO 5 and 24, which is consistent with results from 2019 modeling.

The updated model is considered appropriate for evaluating improvements to the collection system.

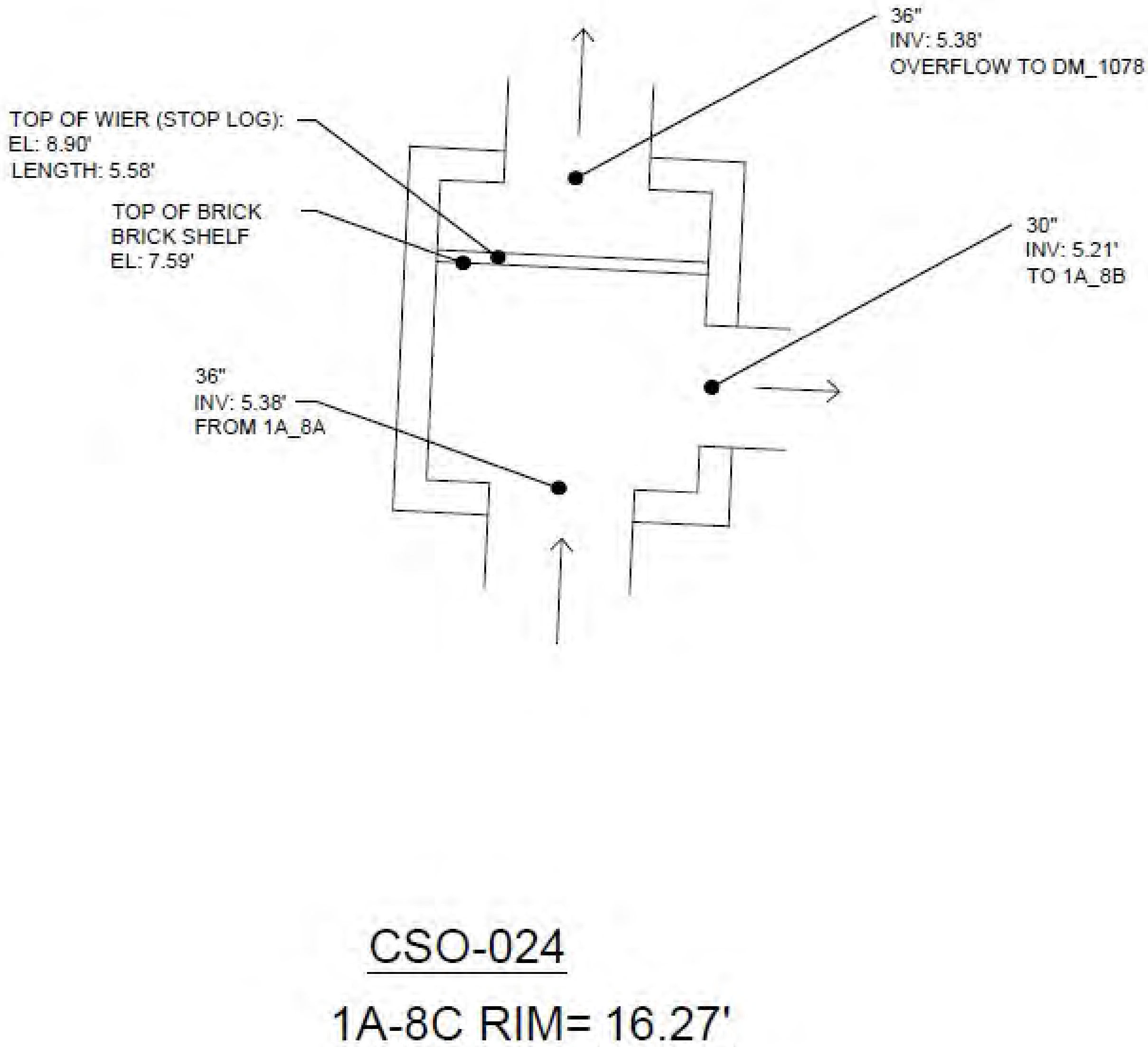
Attachment A: Regulator Sketches



CSO 005 Regulator Sketch



CSO 006 Regulator Sketch



CSO 024 Regulator Sketch

Attachment B: Comparison of Information Provided for Regulators

Comparison of Information provided for CSO 005

Model Layer Item	Information provided by Regulator Sketches	Information provided by Aerial Photographs	Information included in Updated SWMM Model
Conduit 1E_6-1E_7	diameter: 48" (inlet el.) INV: 16.86'	diameter: 48" (inlet el.) INV OUT=16.86'	diameter: 48" (inlet el.) INV: 16.86'
Conduit 1E_51D-1E_6	diameter: 36.5" (outlet el.) INV: 16.97'	(inlet el.) INV OUT=16.74' NE	diameter: 36.5" (inlet el.) INV OUT=16.74' NE (outlet el.) INV: 16.97'
Conduit 1E_6_weir-DM_0774	diameter: 30" INLET EL: 16.88' OUTLET EL: 16.87'	diameter: 30" (outlet el.) INV IN=16.87'	diameter: 30" INLET EL: 16.88' OUTLET EL: 16.87'
Conduit 1E_51C-1E_6	diameter: 23.5" (outlet el.) INV: 18.56'	diameter: 24" (inlet el.) INV OUT=18.85'	diameter: 24" (inlet el.) INV OUT=18.85' (outlet el.) INV: 18.56'
Weir 1--CSO_005	EL: 21.13' LENGTH (centerline): 6.83'	N/A	EL: 21.13 LENGTH (centerline): 6.83'
Conduit 1E_6-1E_5	diameter: 36" (inlet el.) INV: 16.94'	diameter: 36" (outlet el.) INV IN=16.22'	diameter: 36" (inlet el.) INV: 16.94' (outlet el.) INV IN=16.22'
Junction 1E_6	RIM = 28.83'	RIM = 28.83' (North) RIM = 28.89' (South)	INV=16.69' RIM = 28.83'
Junction 1E_51D	N/A	RIM=28.35'	INV=16.74' RIM=28.35'
Conduit 1E_27A-1E_51D	N/A	diameter: 36" (outlet el.) INV IN=18.39' S	diameter: 36" (outlet el.) INV IN=18.39' S

Conduit 1E_51E-1E_51D	N/A	(outlet el.) INV IN=17.18' W	(outlet el.) INV IN=17.18' W
Junction 1E_5	N/A	RIM=29.22'	INV=15.91' RIM=29.22'
Conduit 1E_5-1E_4	N/A	diameter: 36" (inlet el.) INV OUT=15.91'	diameter: 36" (inlet el.) INV OUT=15.91'
Junction DM_0774	N/A	RIM=28.67'	INV=16.68' RIM=28.67'
Junction 1E_51C	N/A	RIM=28.10'	INV=18.23' RIM=28.10'
Conduit 1E_51B-1E_51C	N/A	diameter: 12" (outlet el.) INV IN=19.58' N	diameter: 12" (outlet el.) INV IN=19.58' N
Conduit 1E_41-1E_51C	N/A	diameter: 24" (outlet el.) INV IN=19.30' NE	diameter: 24" (outlet el.) INV IN=19.30' NE

Comparison of Information provided for CSO 006

Model Layer Item	Information provided by Regulator Sketches	Information provided by Aerial Photographs	Information included in Updated SWMM Model
Conduit 1A_76-1A_76A	diameter: 40" (outlet el.) INV: 12.45'	diameter: 40" (outlet el.) INV IN=12.45'	diameter: 40" (inlet el.) INV OUT=12.48' (outlet el.) INV: 12.45'
Conduit NF_149-BC_11	diameter: 36" (inlet el.) INV: 12.44'	diameter: 36" (inlet el.) INV OUT=12.44'	diameter: 36" (inlet el.) INV: 12.44'
Weir W_006--CSO_006	EL: 17.07’ LENGTH (centerline): 7.92' LENGTH (upstream face): 8.42'	N/A	EL: 17.07’ LENGTH (centerline): 7.92'
Junction 1A_76A	RIM = 24.43'	RIM=24.43'	RIM = 24.43'
Junction 1A_76B	N/A	RIM=24.47'	RIM=24.47'
Conduit 1A_76A-1A_76B	N/A	diameter: 33" (outlet el.) INV IN=12.44'	diameter: 33" (inlet el.) INV OUT=12.25' (outlet el.) INV IN=12.44'
Conduit 1C_1-1A_76B	N/A	diameter: 18" (outlet el.) INV IN=13.68'	diameter: 18" (outlet el.) INV IN=13.68'
Conduit 1A_76B-1A_76C	N/A	diameter: 36" (inlet el.) INV OUT=12.64' (outlet el.) INV IN=12.22'	diameter: 36" (inlet el.) INV OUT=12.64' (outlet el.) INV IN=12.22'
Conduit 1A_76D-1A_76C	N/A	diameter: 12" (outlet el.) INV IN=15.89'	diameter: 12" (outlet el.) INV IN=15.89'
Conduit 1A_76C-1A_71A	N/A	diameter: 36" (inlet el.) INV OUT=11.51'	diameter: 36" (inlet el.) INV OUT=11.51'

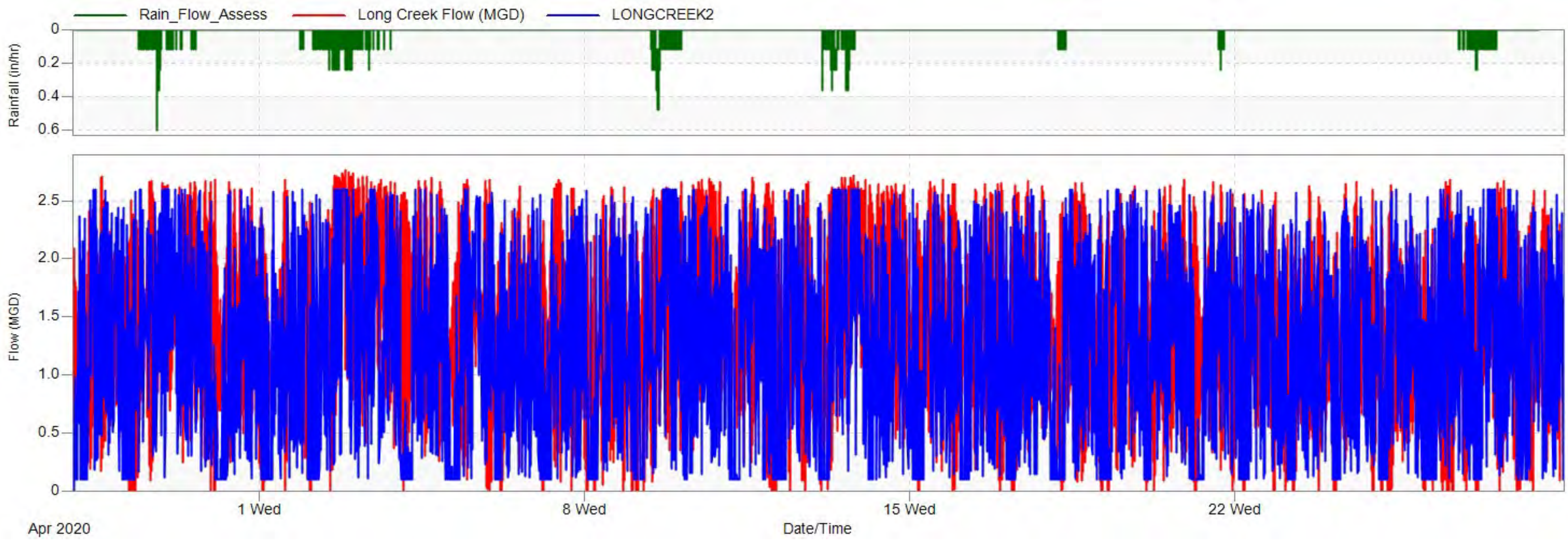
Junction 1A_76D	N/A	RIM=25.01'	RIM=25.01'
Junction 1A_76	N/A	RIM=24.92'	RIM=24.92'
Conduit 1D_1-1A_76	N/A	diameter: 36" (outlet el.) INV IN=12.51'	diameter: 36" (outlet el.) INV IN=12.51'
Conduit 1B_1-1A_76	N/A	diameter: 24" (outlet el.) INV IN=13.59'	diameter: 24" (outlet el.) INV IN=13.59'

Comparison of Information provided for CSO 024

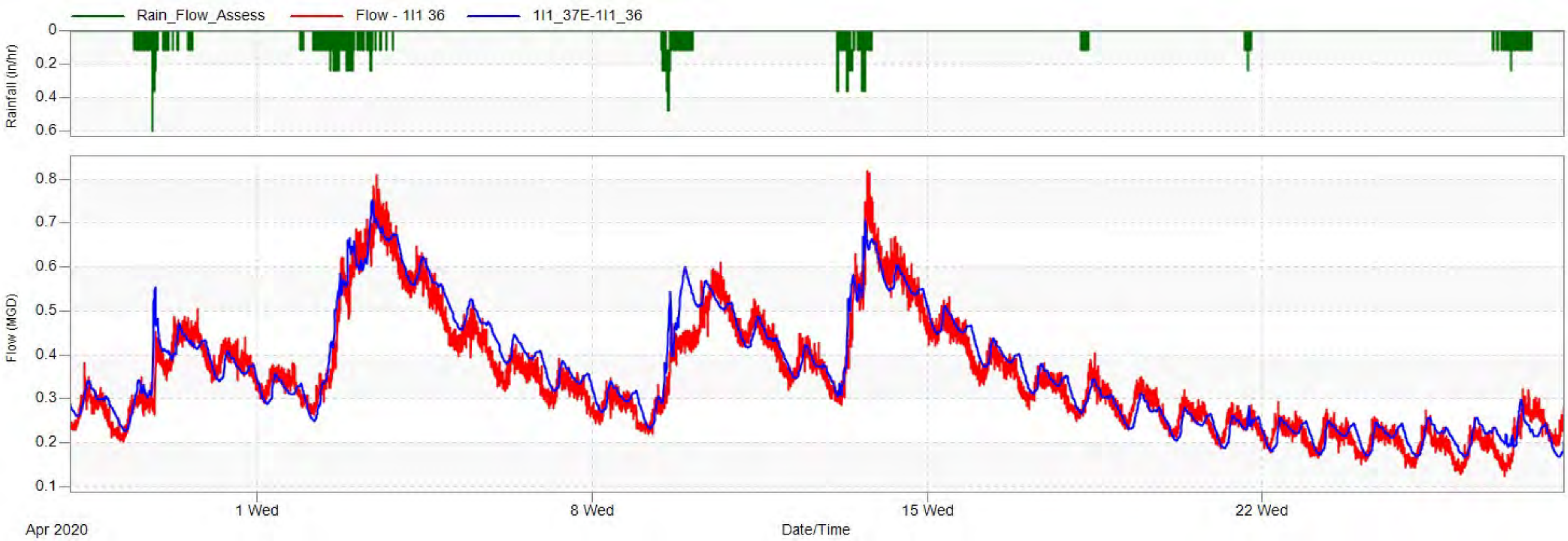
Model Layer Item	Information provided by Regulator Sketches	Information provided by Aerial Photographs	Information included in Updated SWMM Model
Weir W_024--CSO_024	EL: 8.90’ LENGTH: 5.58'	N/A	EL: 8.90' LENGTH: 5.58'
Conduit 1A_8C_weir-DM_1078	diameter: 36" (inlet el.) INV: 5.38'	diameter: 36" (inlet el.) INV OUT=5.38' (outlet el.) INV IN=5.32'	diameter: 36" (inlet el.) INV: 5.38' (outlet el.) INV IN=5.32'
Conduit 1A_8A-1A_8C	diameter: 36" (outlet el.) INV: 5.38'	diameter: 36" (inlet el.) INV OUT=5.47' (outlet el.) INV IN=5.38'	diameter: 36" (inlet el.) INV OUT=5.47' (outlet el.) INV: 5.38'
Conduit 1A_8C-1A_8B	diameter: 30" (inlet el.) INV: 5.21'	diameter: 30" (inlet el.) INV OUT=5.21' (outlet el.) INV IN=5.19'	diameter: 30" (inlet el.) INV OUT=5.21' (outlet el.) INV IN=5.19'
Junction 1A_8C	RIM = 16.27'	RIM=16.27'	diameter: RIM = 16.27'
Outfall DM_1078	N/A	RIM=16.65'	diameter: RIM=16.65'
Junction 1A_8A	N/A	RIM=16.19'	diameter: RIM=16.19'
Conduit 1A_19B-1A_8A	N/A	diameter: 33" (outlet el.) INV IN=5.58'	diameter: 33" (outlet el.) INV IN=5.58'
Junction 1A_8B	N/A	RIM=16.05'	diameter: RIM=16.05'
Conduit 1A_8E-1A_8B	N/A	diameter: 8" (inlet el.) INV IN=7.48'	diameter: 8" (inlet el.) INV IN=7.48'
Conduit 1A_8B-1A_8D	N/A	diameter: 30" (inlet el.) INV OUT=5.18'	diameter: 30" (inlet el.) INV OUT=5.18'

Attachment C: Flow Meter Calibration Plots

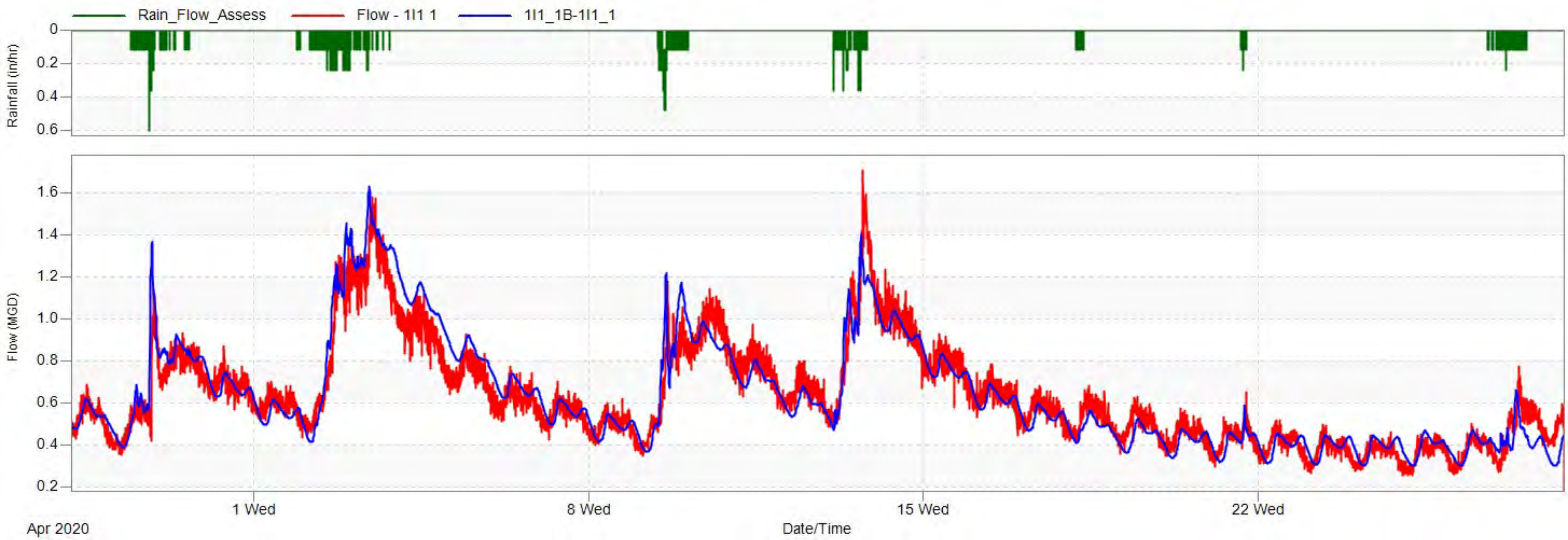
As discussed in the text for Appendix C, some plots show better correlation than others between meter data and model predictions. This is typical for CSO modeling efforts. Some of the meter data indicate rapid rises and falls in values, which is considered "noise" in the data. The model will typically not replicate noise in the data and a more steady condition is generally predicted.



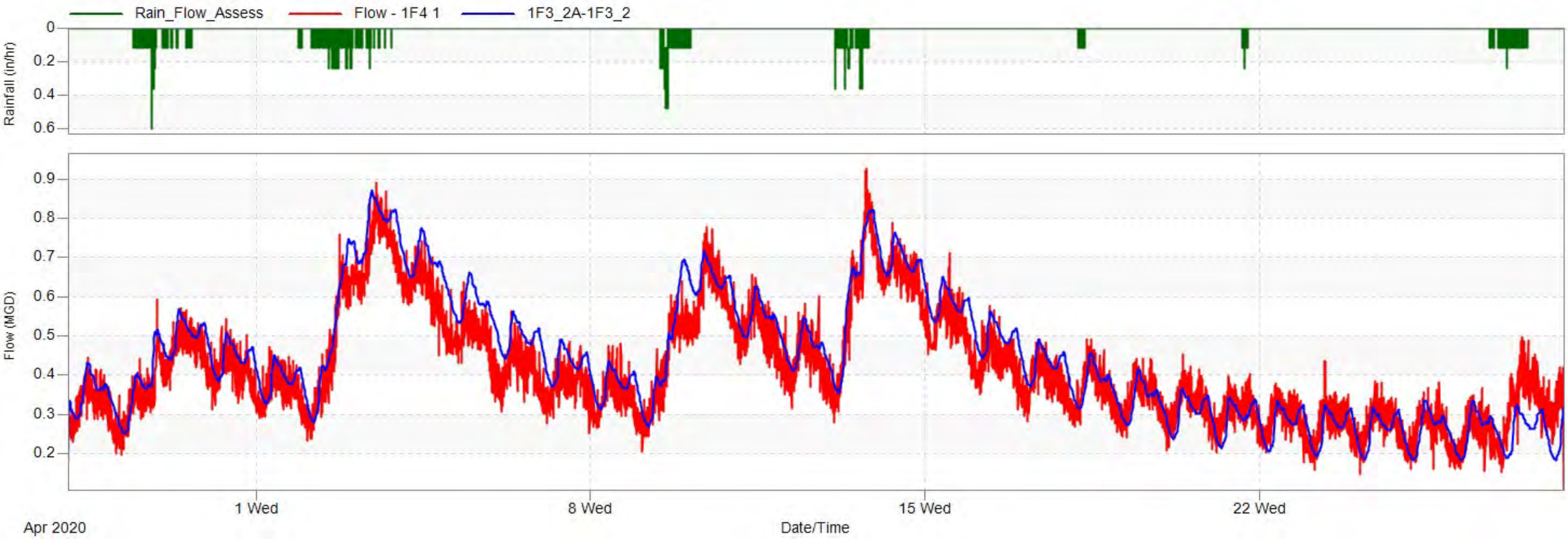
Comparison of Measured and Modeled Flow Meter PS_23 from March 28 to April 28, 2020



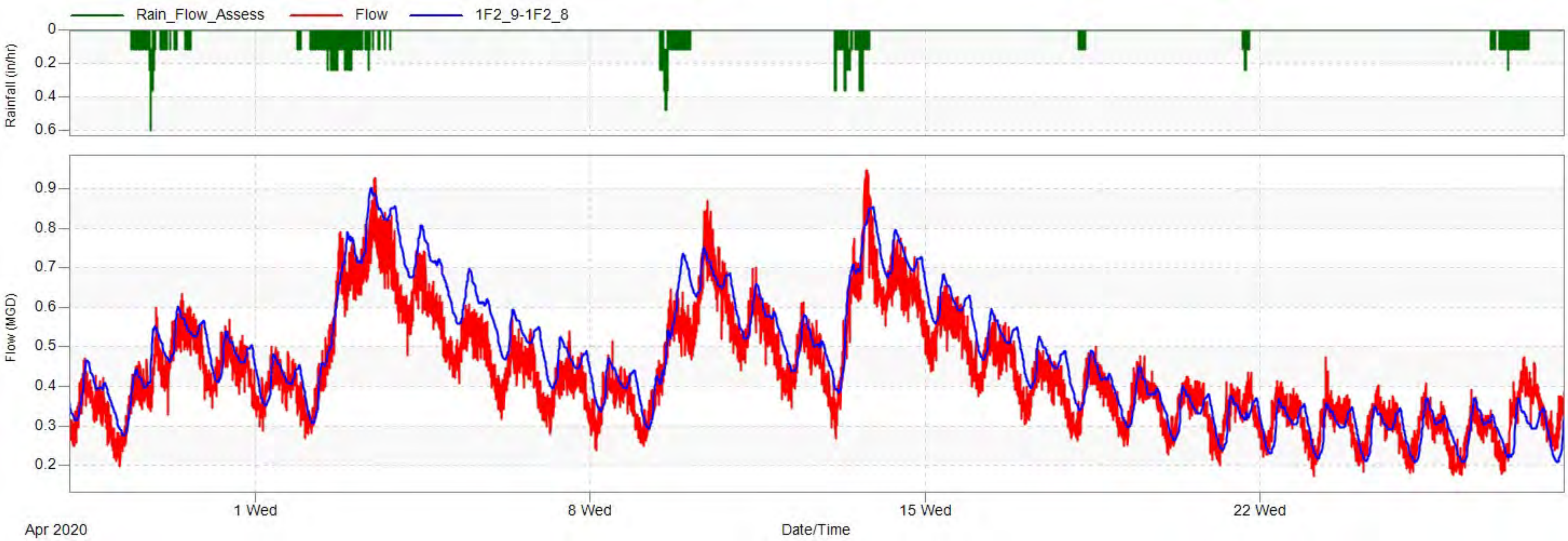
Comparison of Measured and Modeled Flow Meter 1I1_36 from March 28 to April 28, 2020



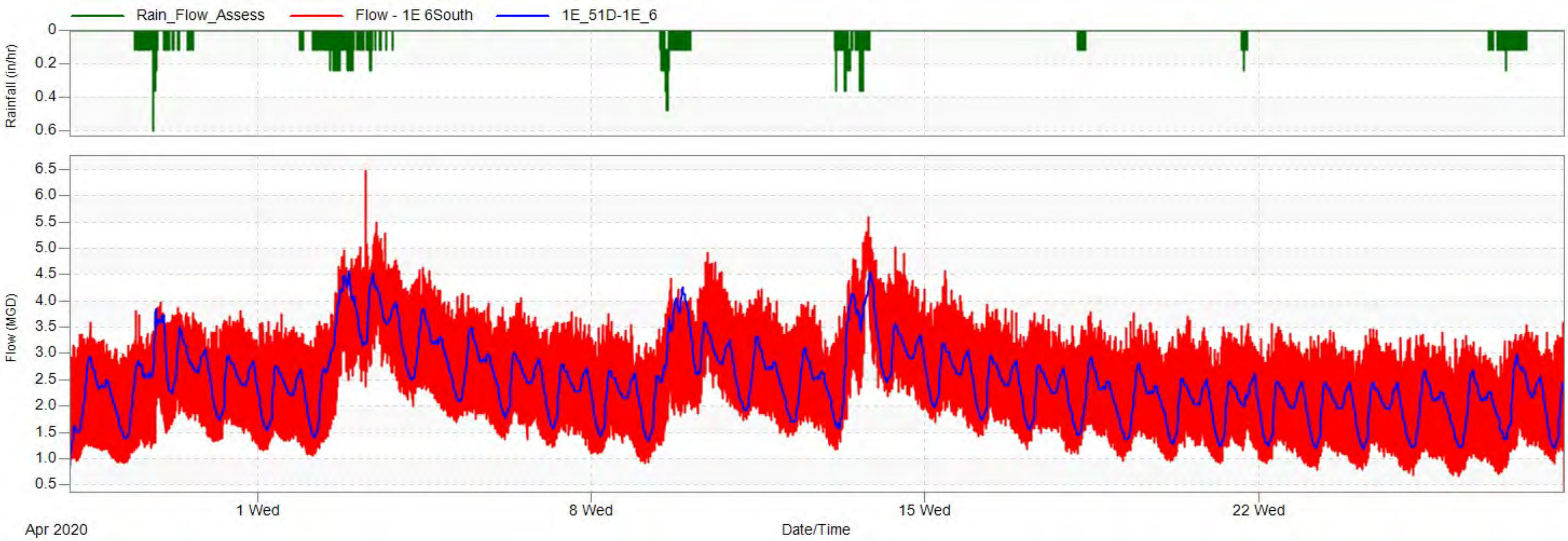
Comparison of Measured and Modeled Flow Meter 1I1_1 from March 28 to April 28, 2020



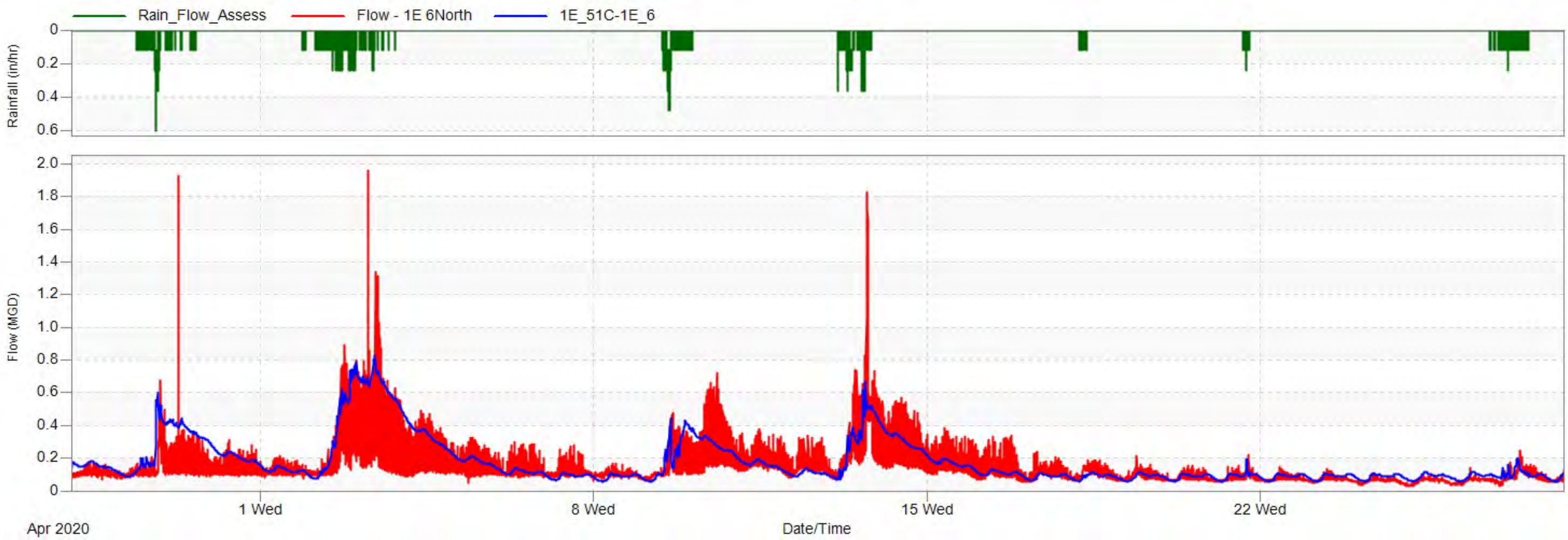
Comparison of Measured and Modeled Flow Meter 1F3_2 (1F4_1) from March 28 to April 28, 2020



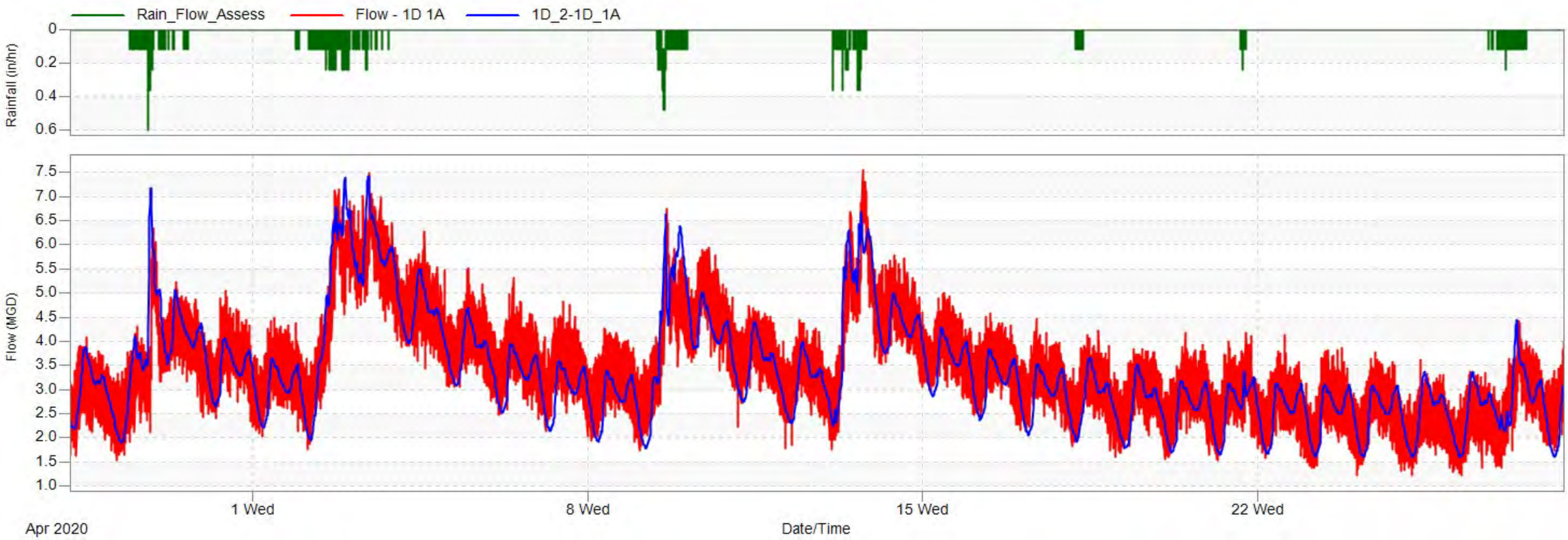
Comparison of Measured and Modeled Flow Meter 1F2_8 from March 28 to April 28, 2020



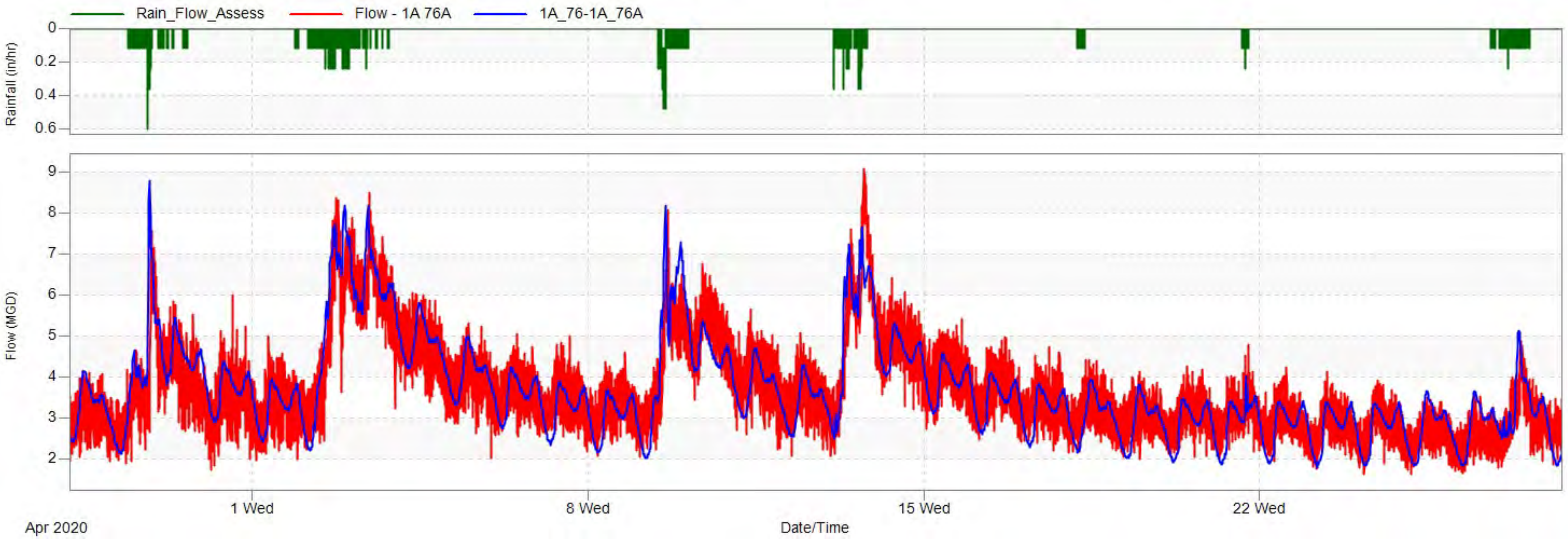
Comparison of Measured and Modeled Flow Meter 1E_6South from March 28 to April 28, 2020



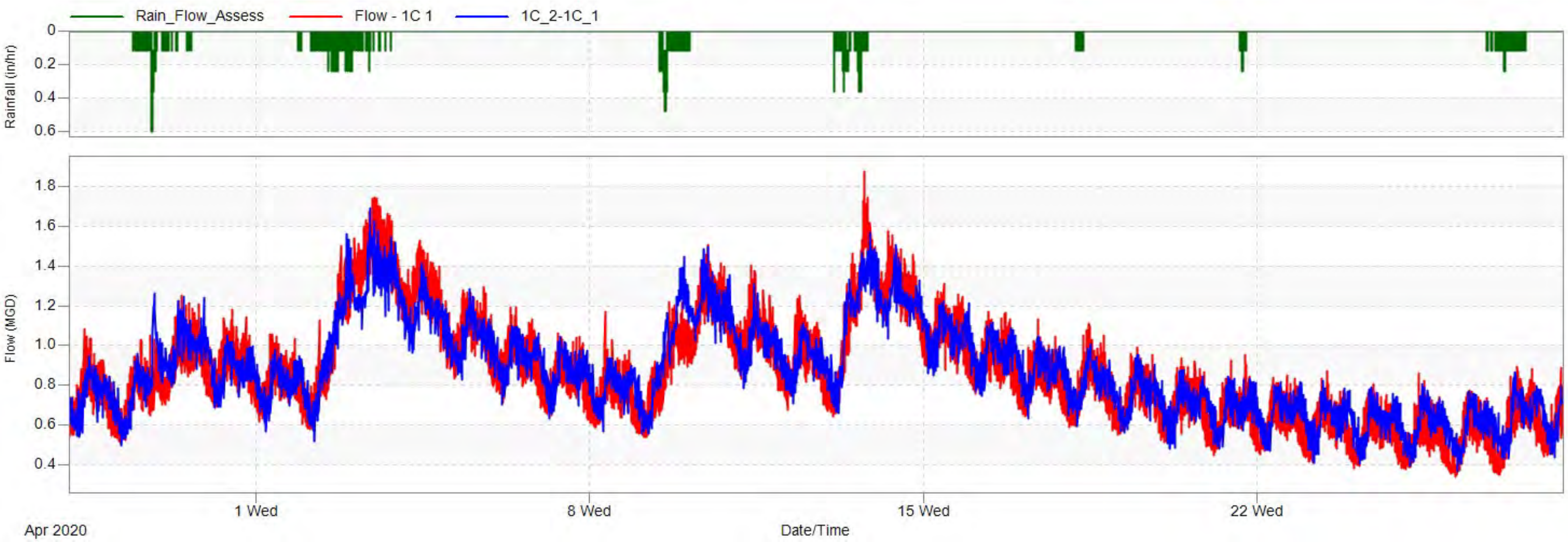
Comparison of Measured and Modeled Flow Meter 1E_6North from March 28 to April 28, 2020



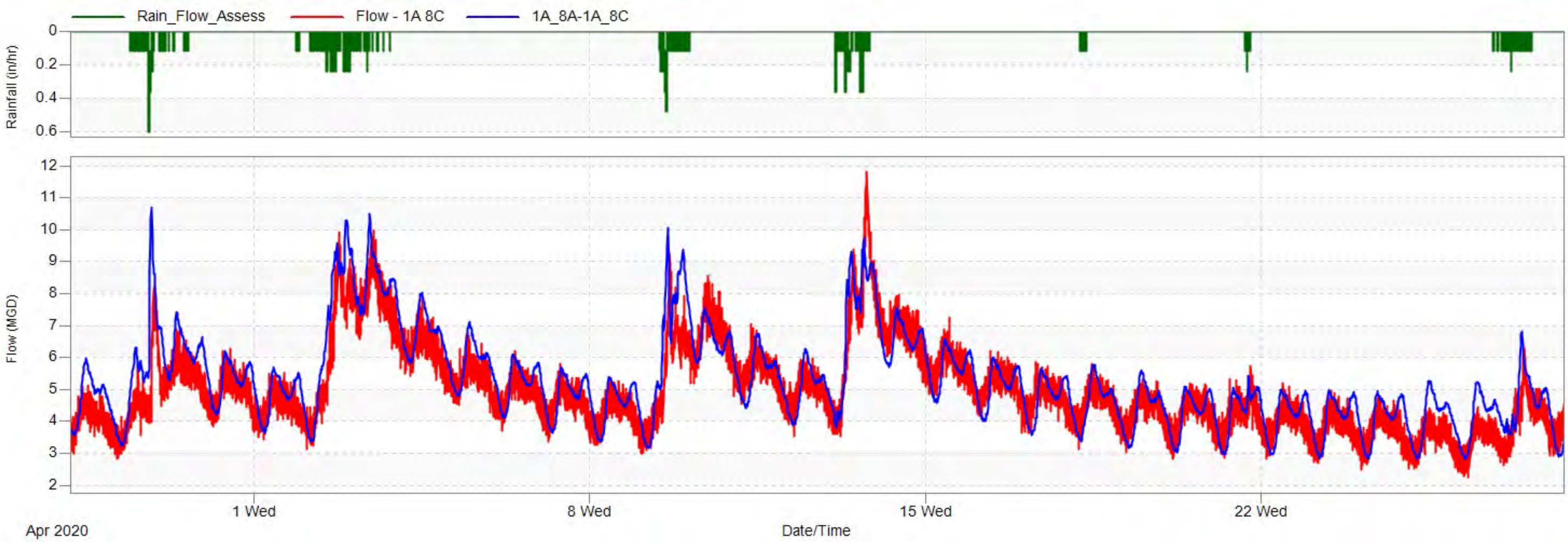
Comparison of Measured and Modeled Flow Meter 1D_1A from March 28 to April 28, 2020



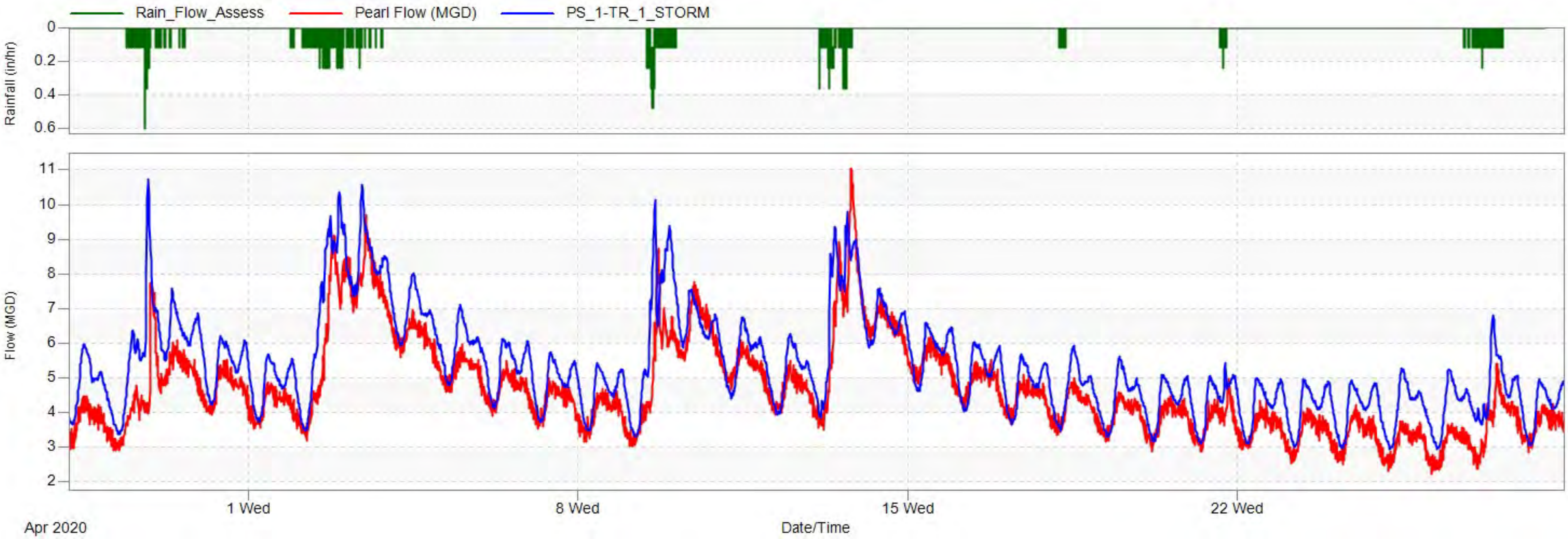
Comparison of Measured and Modeled Flow Meter 1A_76A from March 28 to April 28, 2020



Comparison of Measured and Modeled Flow Meter 1C_1 from March 28 to April 28, 2020

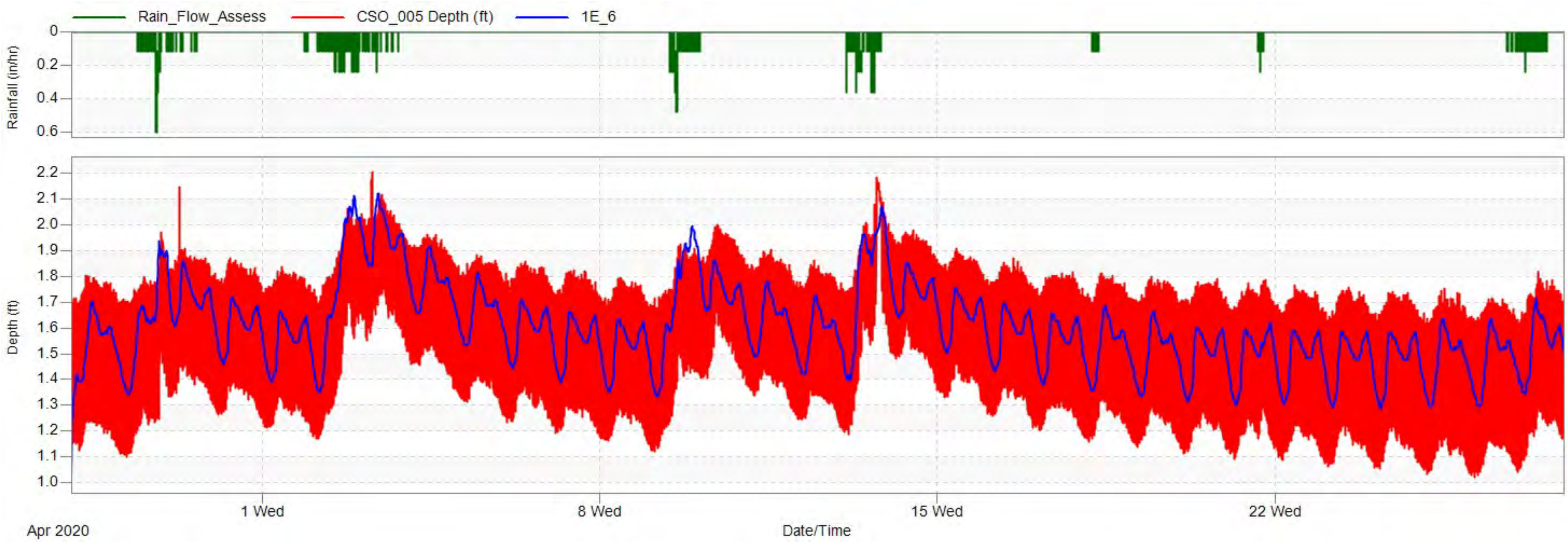


Comparison of Measured and Modeled Flow Meter 1A_8C from March 28 to April 28, 2020

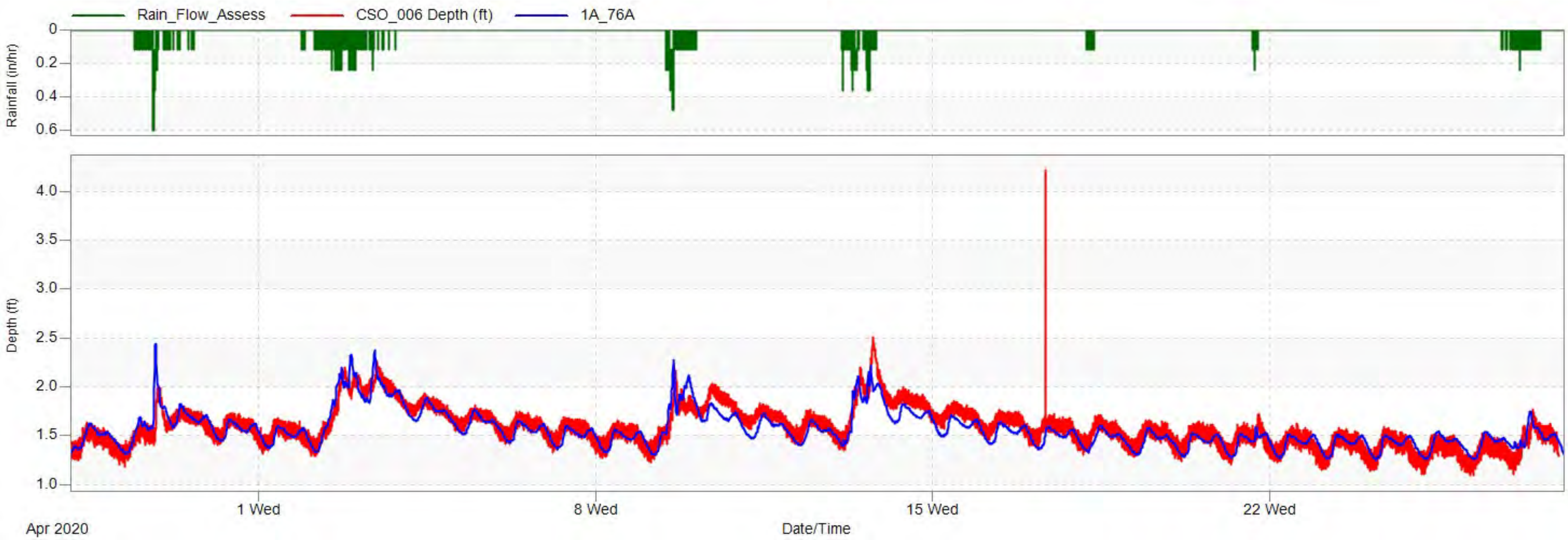


Comparison of Measured and Modeled Flow Meter PS_1 from March 28 to April 28, 2020

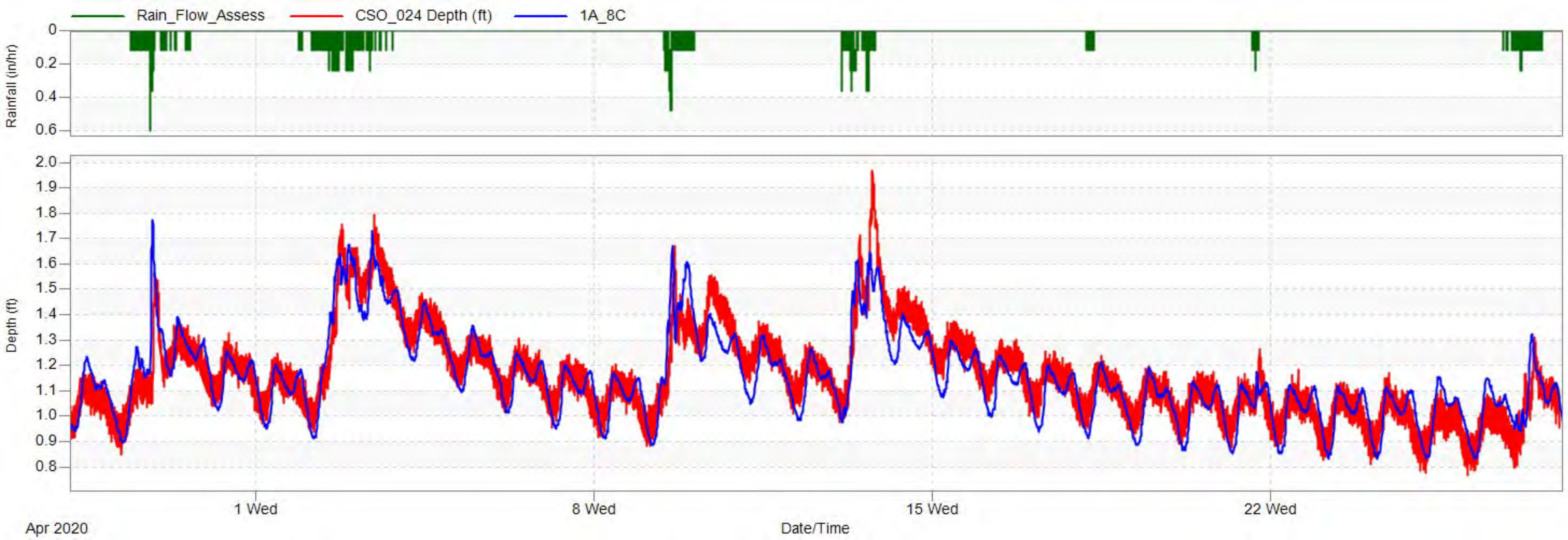
Attachment D: Regulator Water Level Calibration Plots



Comparison of Measured and Modeled CSO 005 Water Level from March 28 to April 28, 2020

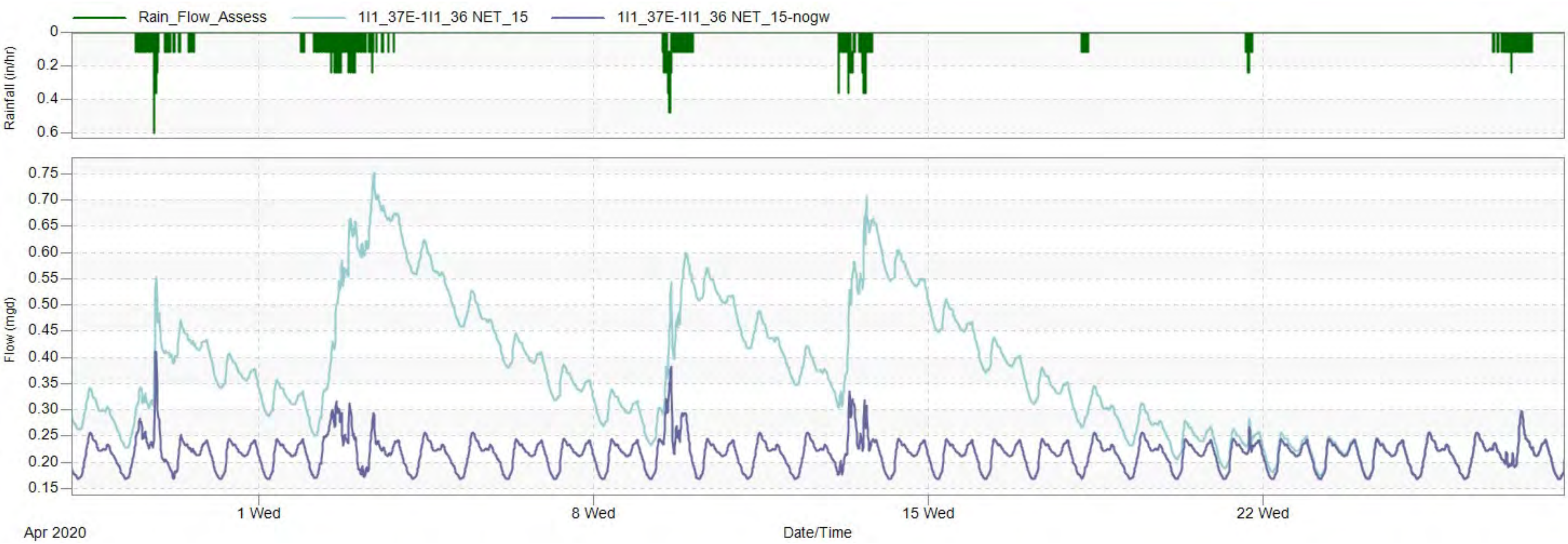


Comparison of Measured and Modeled CSO 006 Water Level from March 28 to April 28, 2020

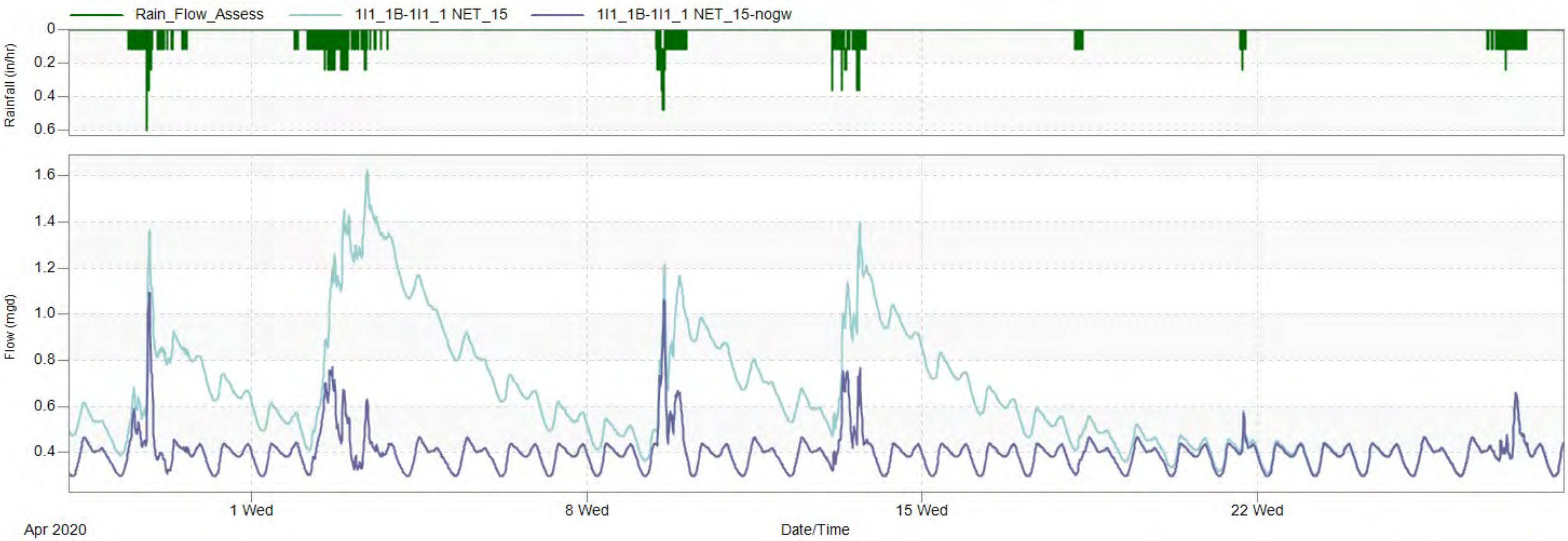


Comparison of Measured and Modeled CSO 024 Water Level from March 28 to April 28, 2020

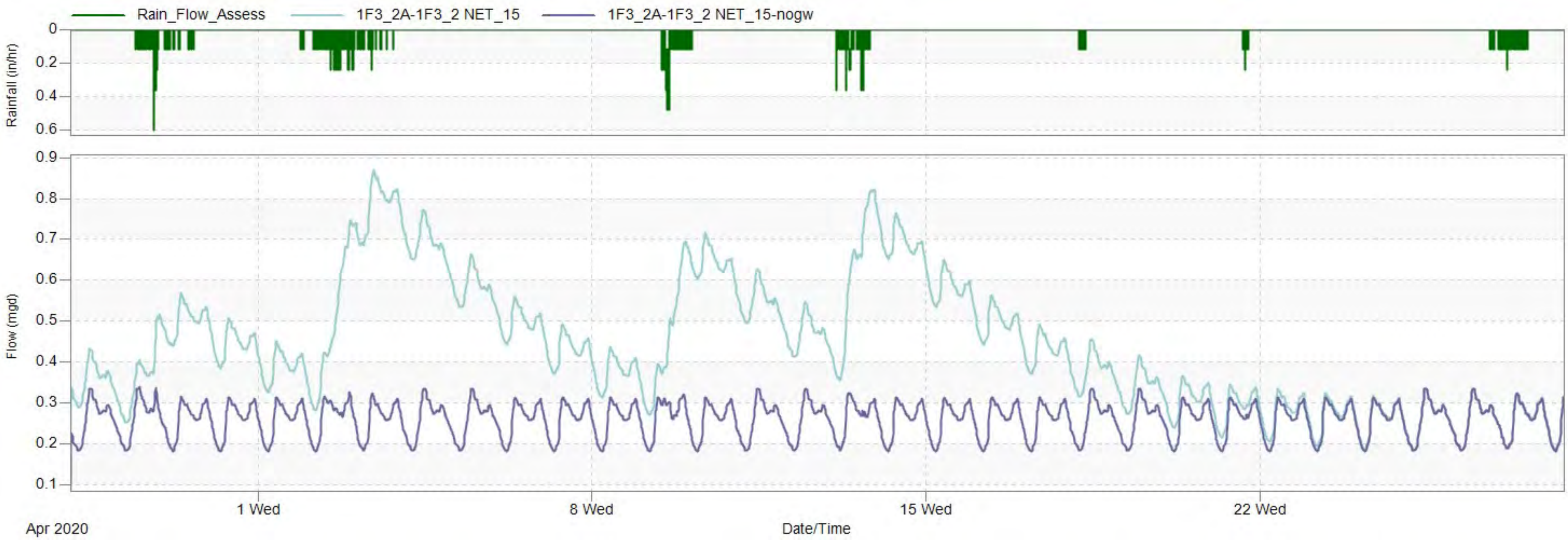
Attachment E: Groundwater Effect



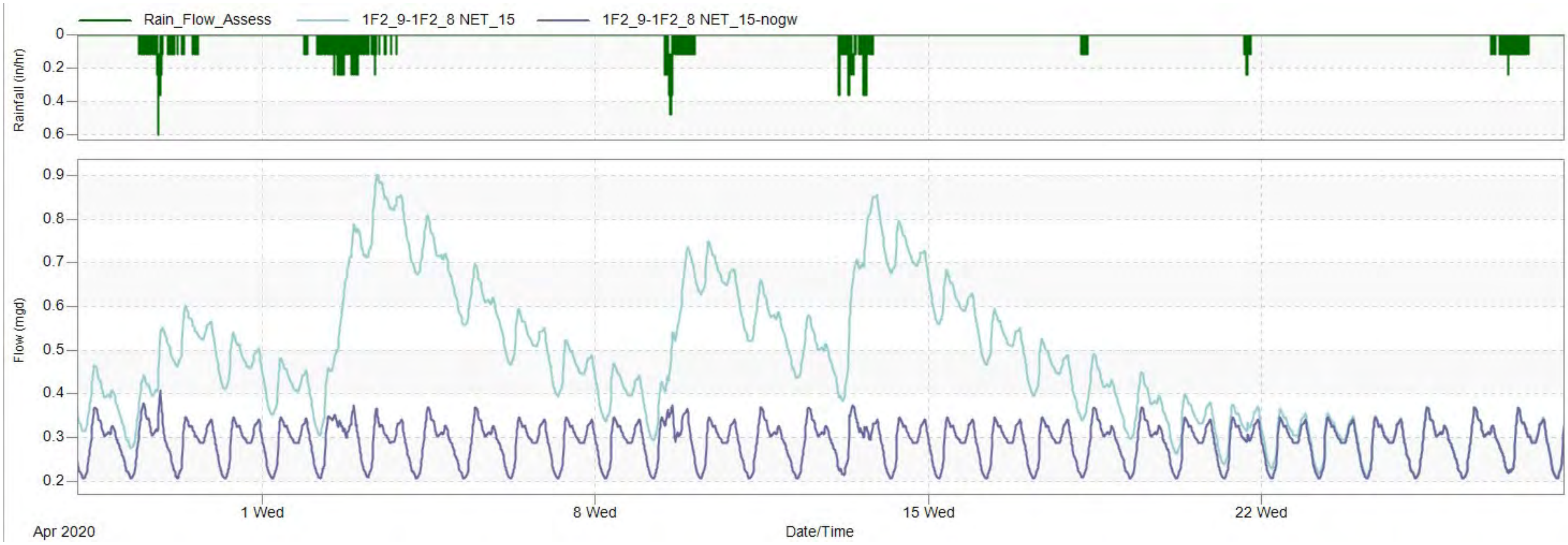
Comparison of Flow Meter 1I1_36 with and without Groundwater from March 28 to April 28, 2020



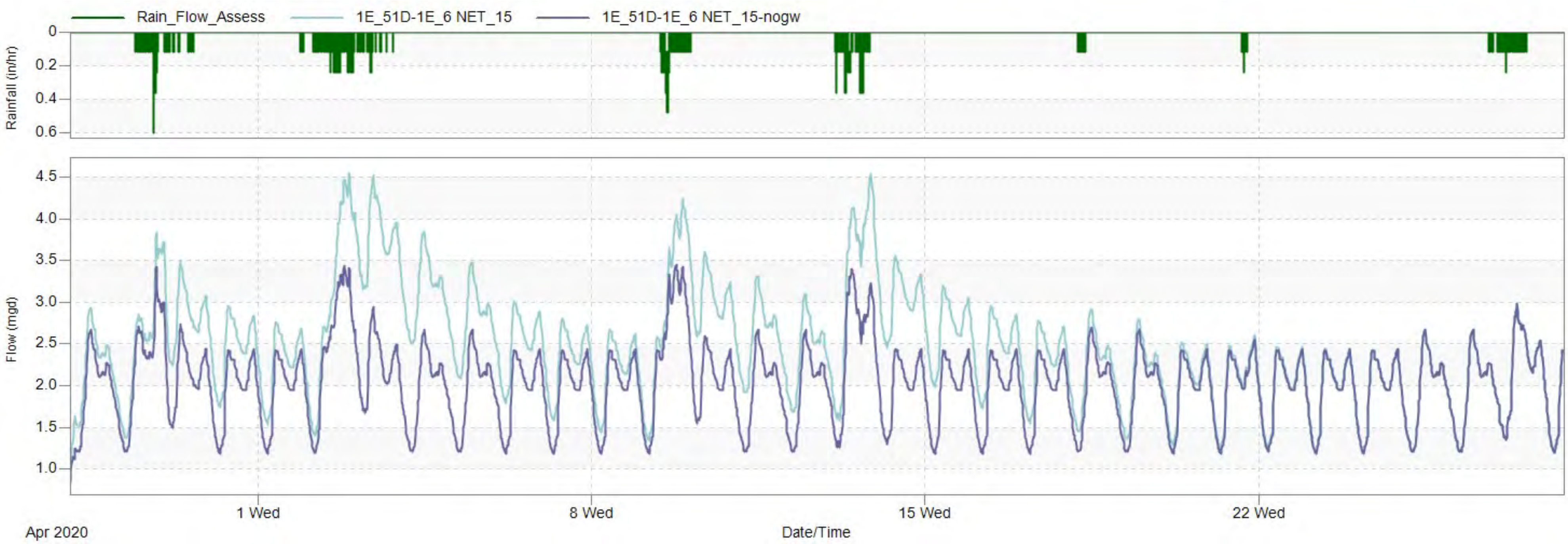
Comparison of Flow Meter 1I1_1 with and without Groundwater from March 28 to April 28, 2020



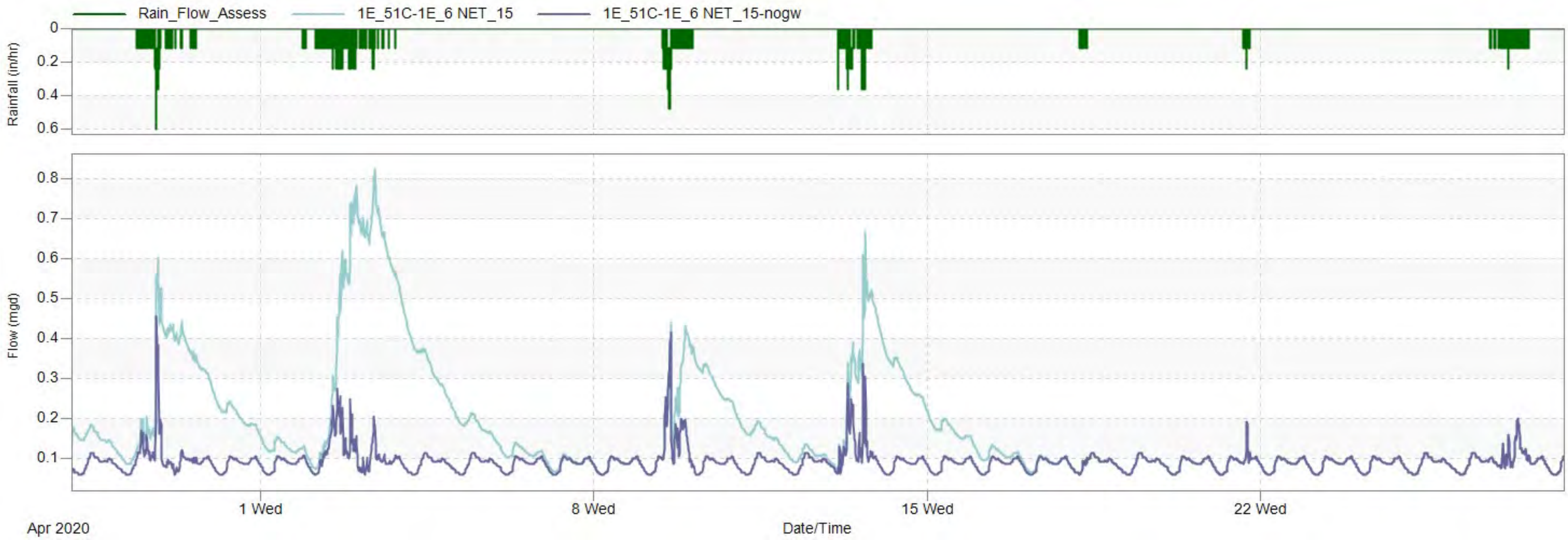
Comparison of Flow Meter 1F3_2 (1F4_1) with and without Groundwater from March 28 to April 28, 2020



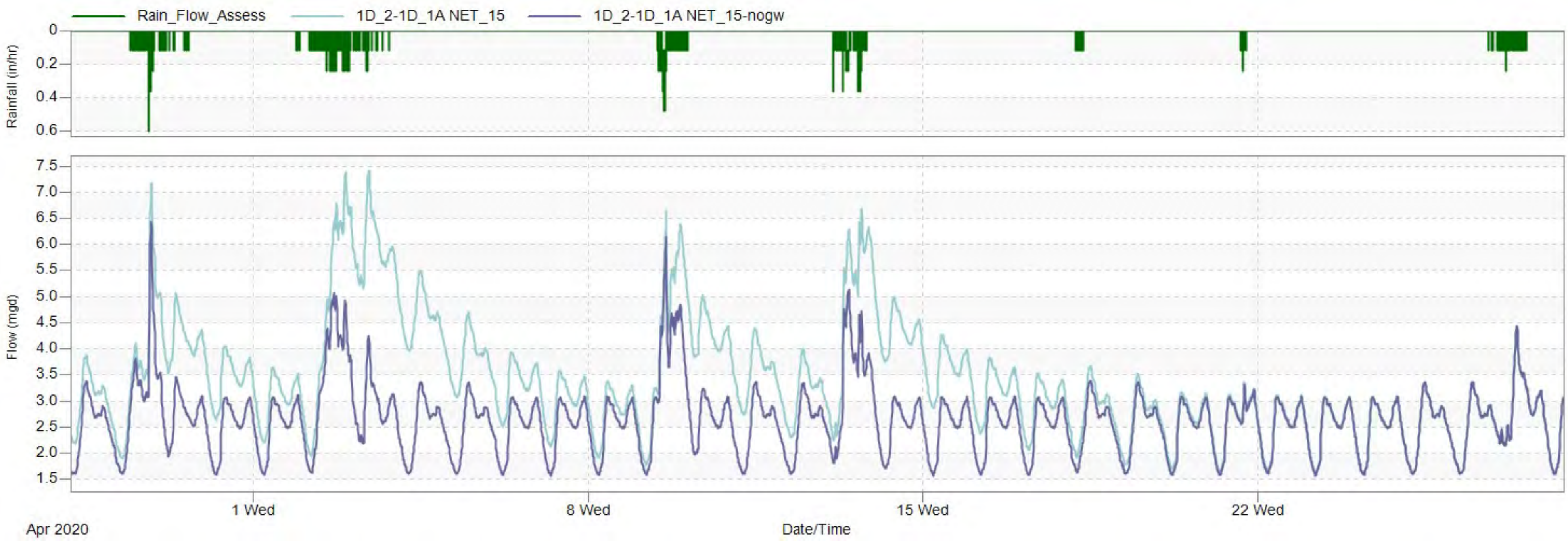
Comparison of Flow Meter 1F2_8 with and without Groundwater from March 28 to April 28, 2020



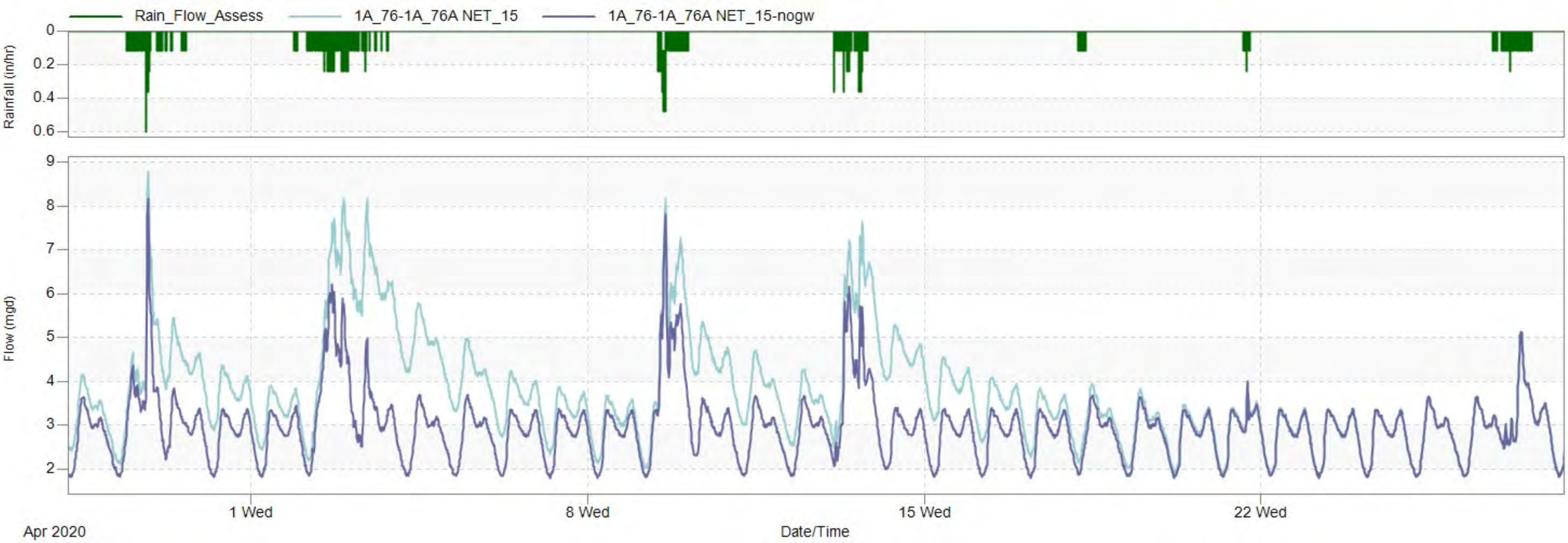
Comparison of Flow Meter 1E_6South with and without Groundwater from March 28 to April 28, 2020



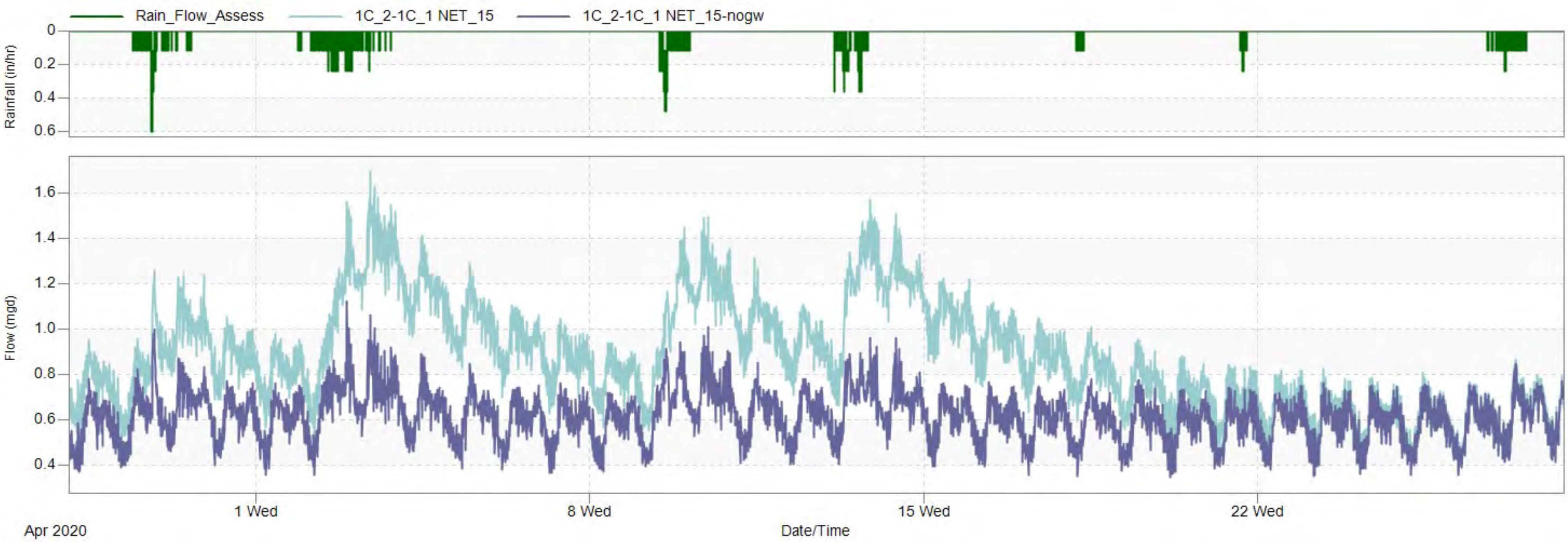
Comparison of Flow Meter 1E_6North with and without Groundwater from March 28 to April 28, 2020



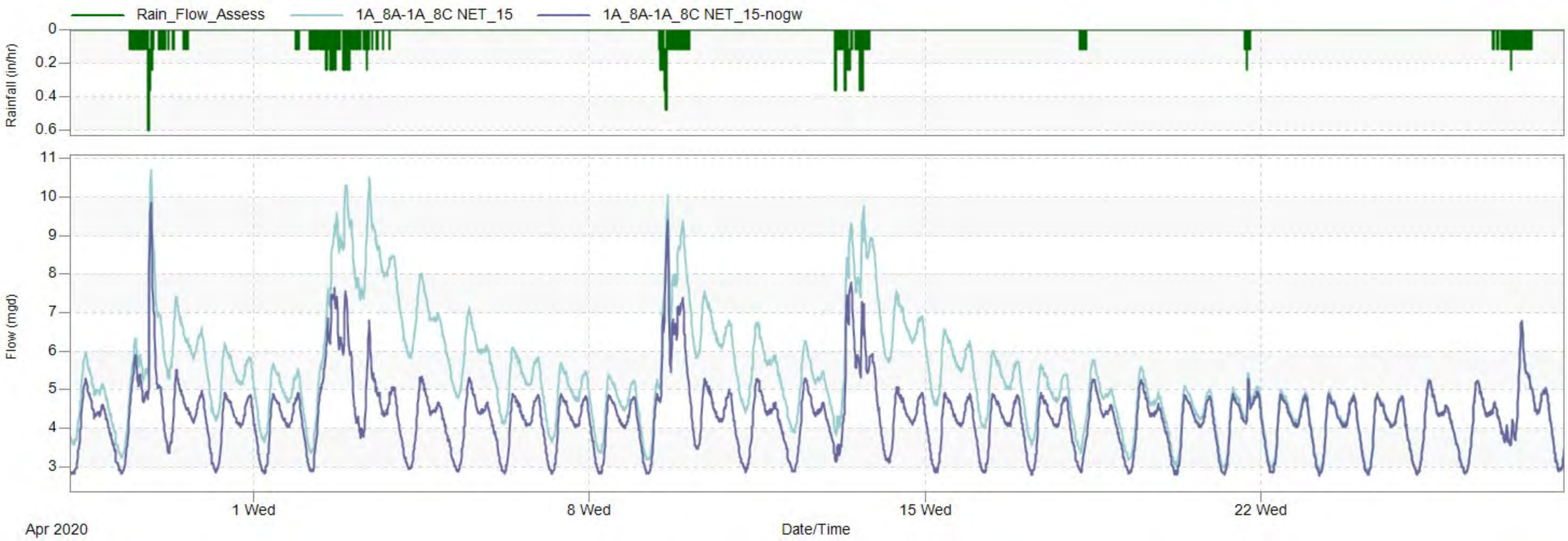
Comparison of Flow Meter 1D_1A with and without Groundwater from March 28 to April 28, 2020



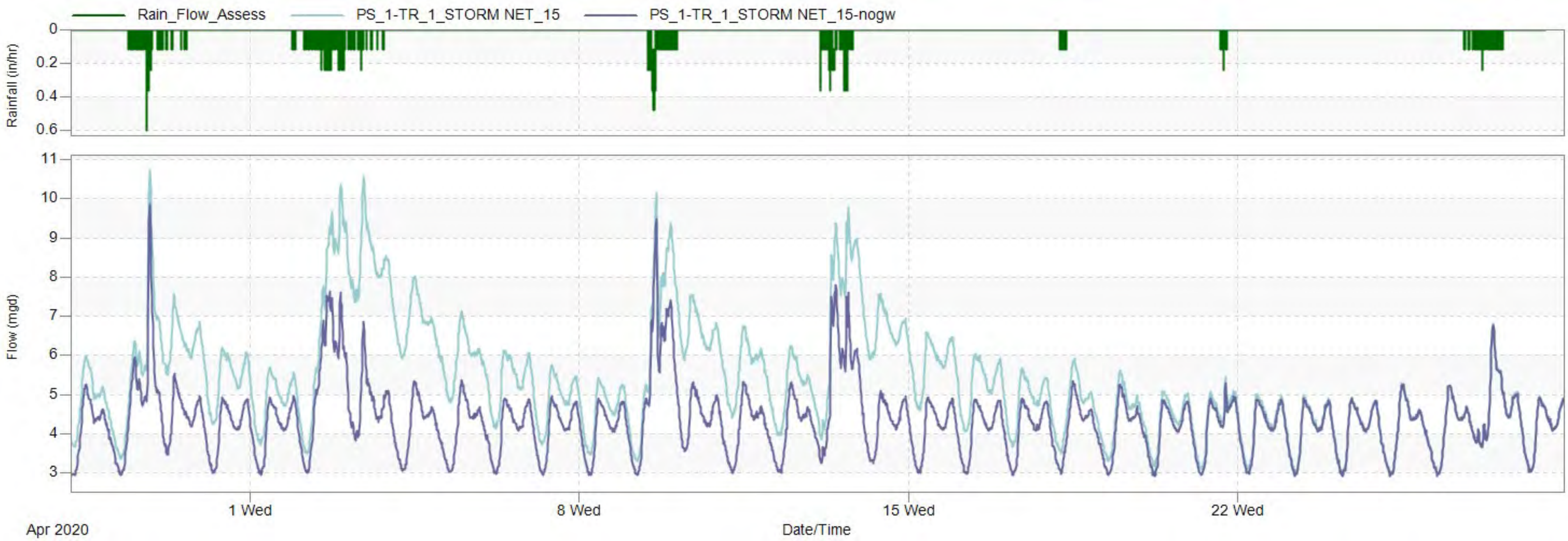
Comparison of Flow Meter 1A_76A with and without Groundwater from March 28 to April 28, 2020



Comparison of Flow Meter 1C_1 with and without Groundwater from March 28 to April 28, 2020

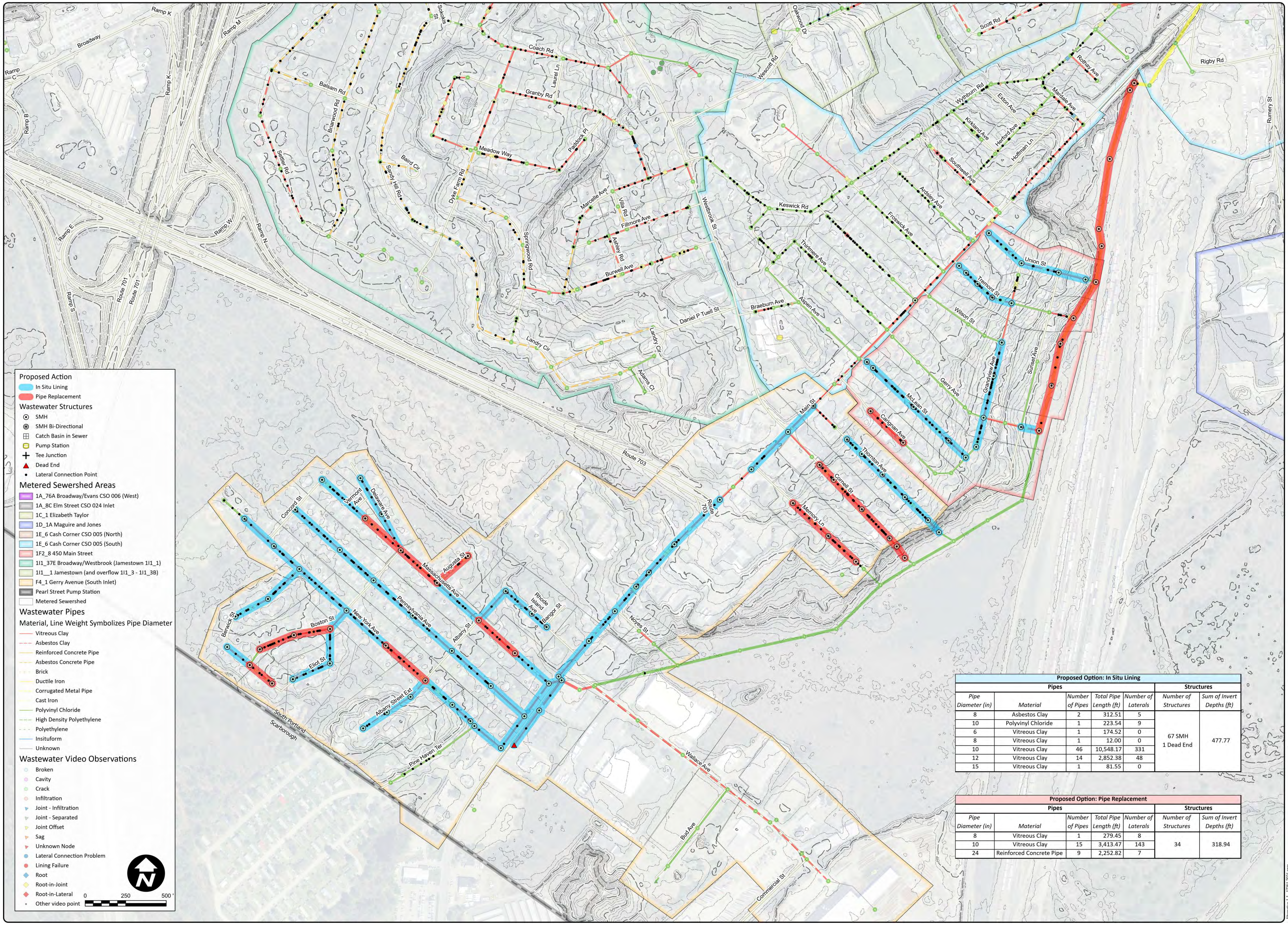


Comparison of Flow Meter 1A_8C with and without Groundwater from March 28 to April 28, 2020



Comparison of Flow Meter PS_1 with and without Groundwater from March 28 to April 28, 2020

APPENDIX C: CONCEPTUAL DESIGNS



Proposed Option: In Situ Lining						
Pipes					Structures	
Pipe Diameter (in)	Material	Number of Pipes	Total Pipe Length (ft)	Number of Laterals	Number of Structures	Sum of Invert Depths (ft)
8	Asbestos Clay	2	312.51	5	67 SMH 1 Dead End	477.77
10	Polyvinyl Chloride	1	223.54	9		
6	Vitreous Clay	1	174.52	0		
8	Vitreous Clay	1	12.00	0		
10	Vitreous Clay	46	10,548.17	331		
12	Vitreous Clay	14	2,852.38	48		
15	Vitreous Clay	1	81.55	0		

Proposed Option: Pipe Replacement						
Pipes					Structures	
Pipe Diameter (in)	Material	Number of Pipes	Total Pipe Length (ft)	Number of Laterals	Number of Structures	Sum of Invert Depths (ft)
8	Vitreous Clay	1	279.45	8	34	318.94
10	Vitreous Clay	15	3,413.47	143		
24	Reinforced Concrete Pipe	9	2,252.82	7		

EXTERNAL DATA SOURCES
2021 orthoRegional Imagery
City of South Portland
ESRI Basemap

REV:	BY:	DATE:	STATUS:

THIS PLAN SHALL NOT BE MODIFIED WITHOUT WRITTEN PERMISSION FROM SEBAGO TECHNICS, INC. ANY ALTERATIONS, AUTHORIZED OR OTHERWISE, SHALL BE AT THE USER'S SOLE RISK AND WITHOUT LIABILITY TO SEBAGO TECHNICS, INC. SOME OR ALL OF THE INFORMATION USED IN THIS GIS PLAN RELIES ON PUBLIC DATA. INTENDED USE OF THIS PLAN IS SOLELY FOR PLANNING PURPOSES. THIS PLAN SHOULD NOT BE USED FOR THE PERMITTING PROCESS.

SEBAGO TECHNICS
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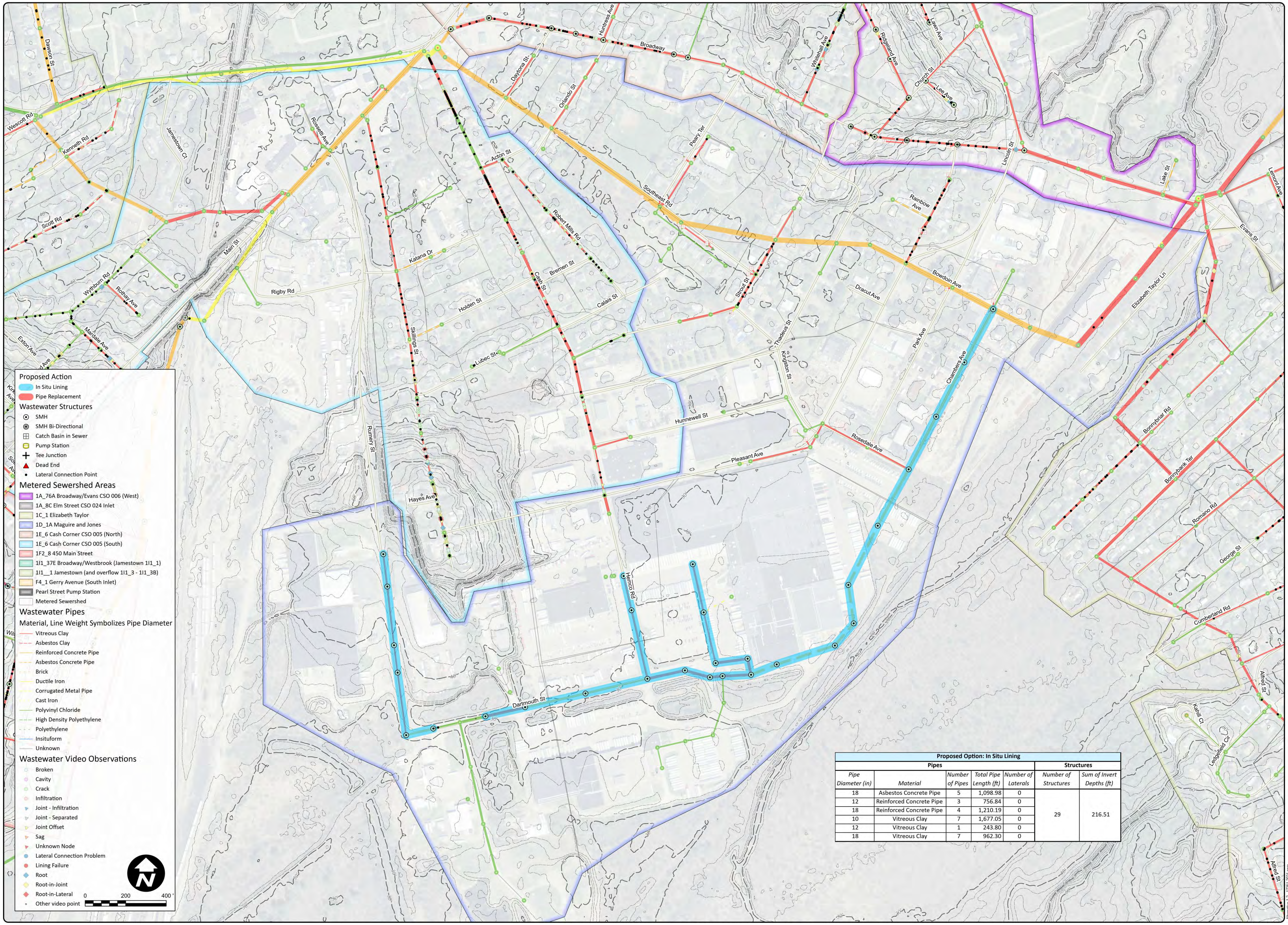
75 John Roberts Rd.
Suite 4A
South Portland, ME 04106
Tel. 207-200-2100

APPENDIX C-1 — ALTERNATIVE 1 AREA 1

OF:

2021 CSO FACILITY PLAN UPDATE
CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 250'
PROJECT	17351



Proposed Option: In Situ Lining						
Pipes					Structures	
Pipe Diameter (in)	Material	Number of Pipes	Total Pipe Length (ft)	Number of Laterals	Number of Structures	Sum of Invert Depths (ft)
18	Asbestos Concrete Pipe	5	1,098.98	0	29	216.51
12	Reinforced Concrete Pipe	3	756.84	0		
18	Reinforced Concrete Pipe	4	1,210.19	0		
10	Vitreous Clay	7	1,677.05	0		
12	Vitreous Clay	1	243.80	0		
18	Vitreous Clay	7	962.30	0		

EXTERNAL DATA SOURCES

2021 orthoRegional Imagery
City of South Portland
ESRI Basemap

REV:	BY:	DATE:	STATUS:

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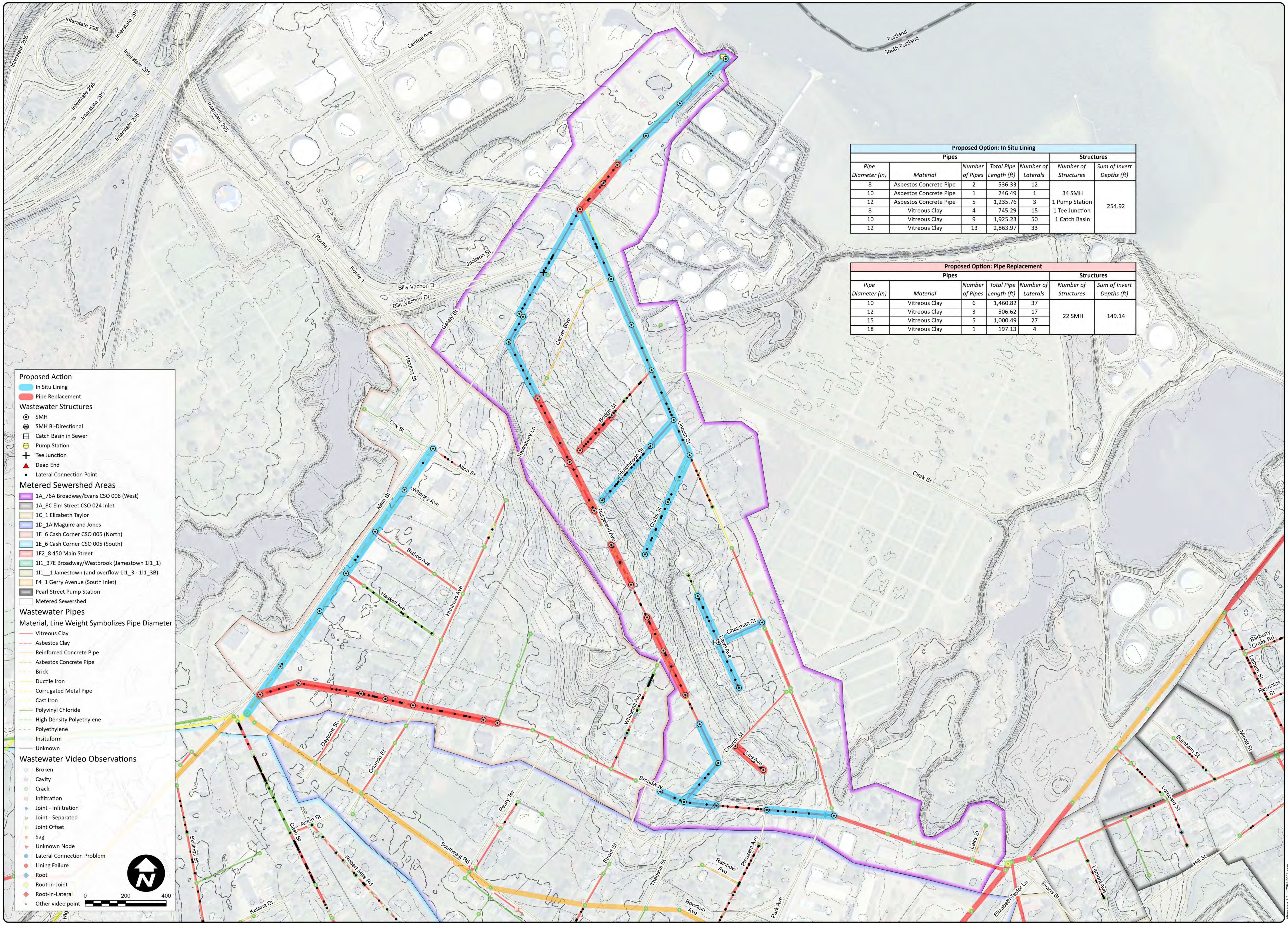
APPENDIX C-1 — ALTERNATIVE 1 AREA 2

OF:

2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 200'
PROJECT	17351



Proposed Option: In Situ Lining						
Pipes					Structures	
Pipe Diameter (in)	Material	Number of Pipes	Total Pipe Length (ft)	Number of Laterals	Number of Structures	Sum of Invert Depths (ft)
8	Asbestos Concrete Pipe	2	536.33	12	34 SMH 1 Pump Station 1 Tee Junction 1 Catch Basin	254.92
10	Asbestos Concrete Pipe	1	246.49	1		
12	Asbestos Concrete Pipe	5	1,235.76	3		
8	Vitreous Clay	4	745.29	15		
10	Vitreous Clay	9	1,925.23	50		
12	Vitreous Clay	13	2,863.97	33		

Proposed Option: Pipe Replacement						
Pipes					Structures	
Pipe Diameter (in)	Material	Number of Pipes	Total Pipe Length (ft)	Number of Laterals	Number of Structures	Sum of Invert Depths (ft)
10	Vitreous Clay	6	1,460.82	37	22 SMH	149.14
12	Vitreous Clay	3	506.62	17		
15	Vitreous Clay	5	1,000.49	27		
18	Vitreous Clay	1	197.13	4		

EXTERNAL DATA SOURCES
2021 orthoRegional Imagery
City of South Portland
ESRI Basemap

REV:	BY:	DATE:	STATUS:

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APPENDIX C-1 — ALTERNATIVE 1 AREA 3

OF:

2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 200'
PROJECT	17351

Alternative 1-3 - 17351-2021.aprx

SHEET 3 OF 3

EXTERNAL DATA SOURCES
2018 ortho/Regional Imagery
City of South Portland
Town of Cape Elizabeth

REV:	BY:	DATE:	STATUS:

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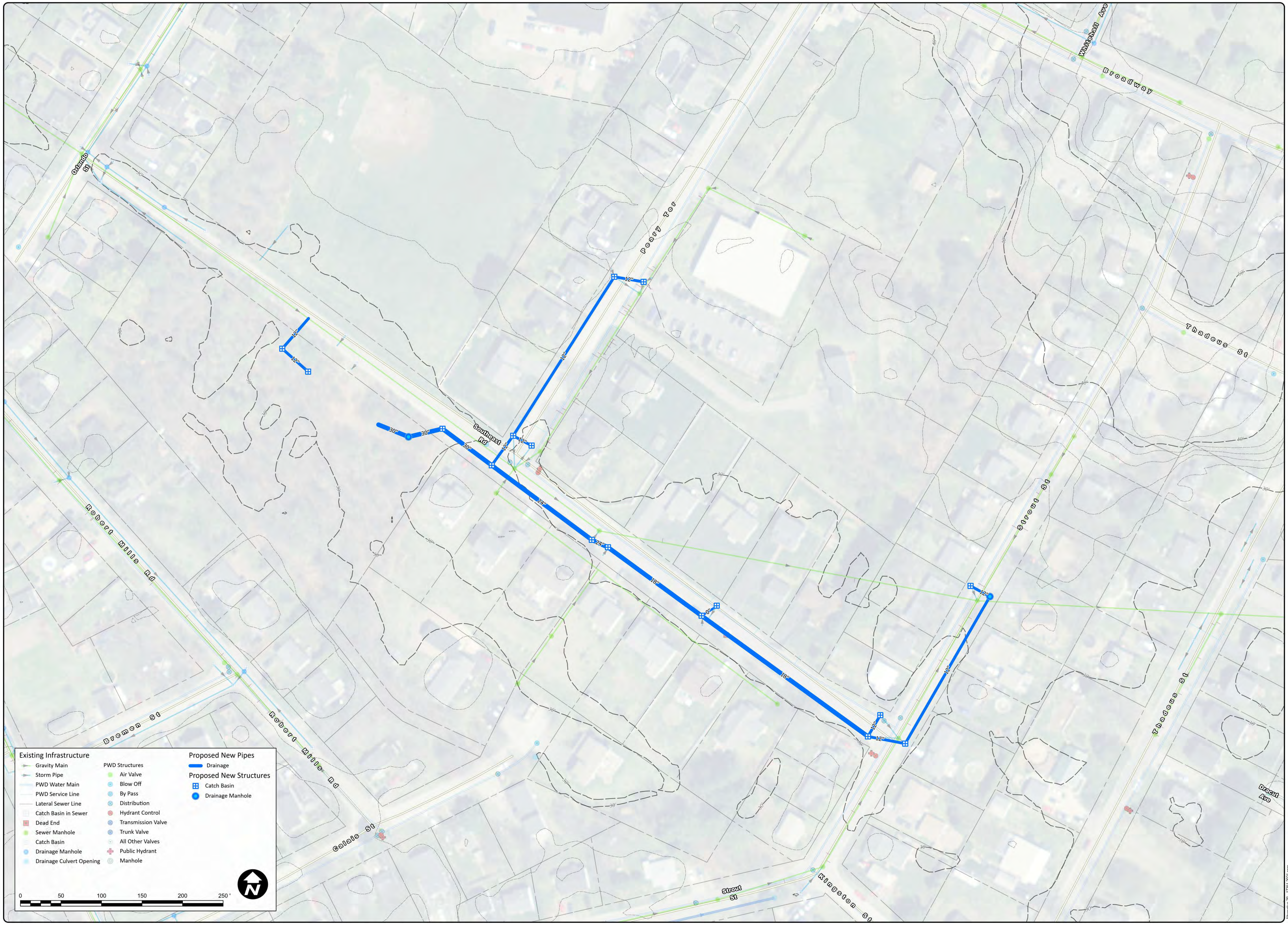
APPENDIX C-2 — ALTERNATIVE 2 AREA 1

OF:

2021 CSO FACILITY PLAN UPDATE
CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 60'
PROJECT	17351

SHEET 1 OF 1



EXTERNAL DATA SOURCES

2018 orthoRegional Imagery
City of South Portland
Town of Cape Elizabeth

REV:	BY:	DATE:	STATUS:

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APPENDIX C-2 — ALTERNATIVE 2 AREA 2

OF:

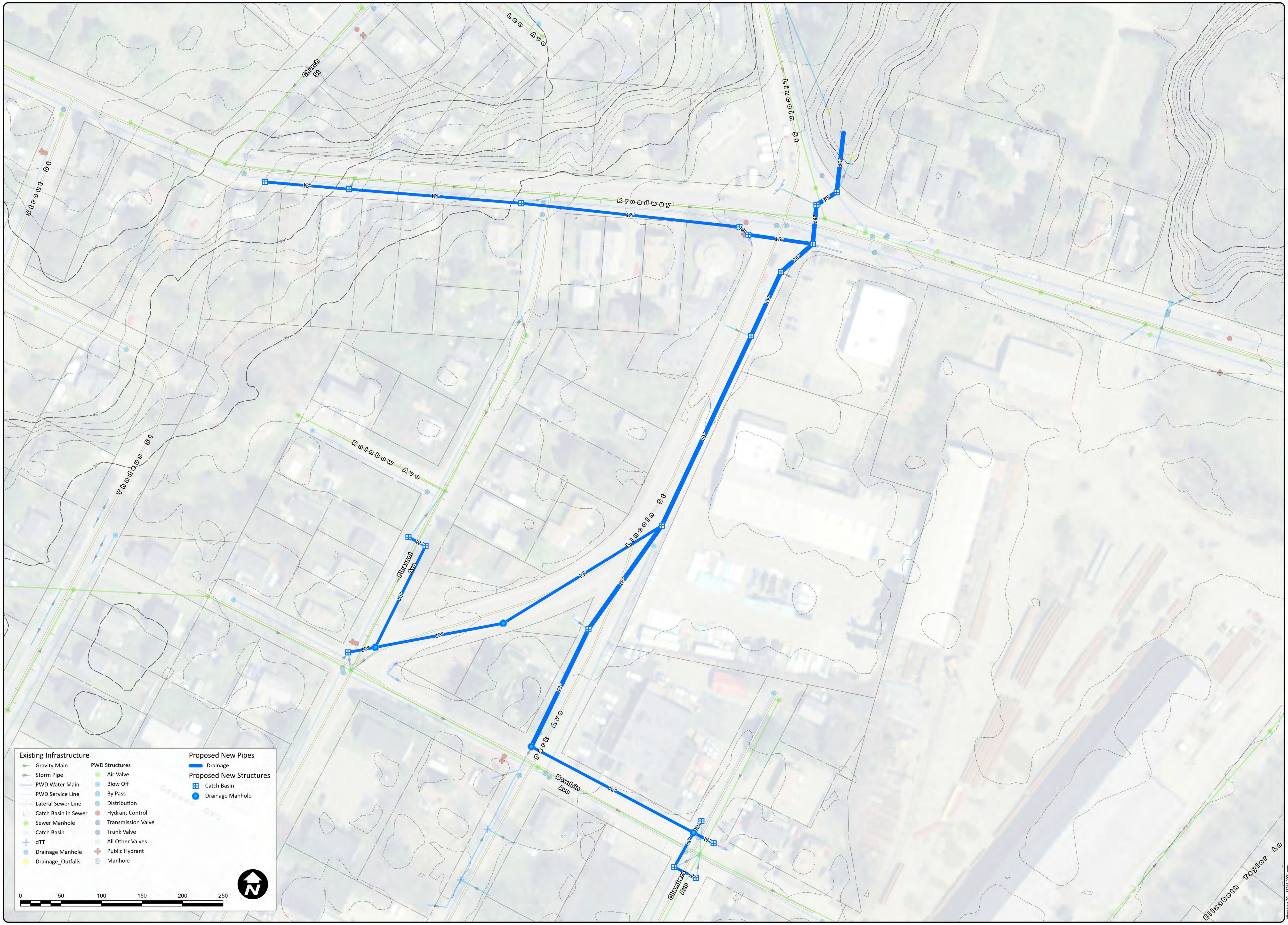
2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 50'
PROJECT	17351

SHEET 1 OF 1

Alternative 2B - 17351-2021.aprx



EXTERNAL DATA SOURCES

2018 orthoRegional Imagery
City of South Portland
Town of Cape Elizabeth

REV:	BY:	DATE:	STATUS:

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APPENDIX C-2 — ALTERNATIVE 2 AREA 3

OF:

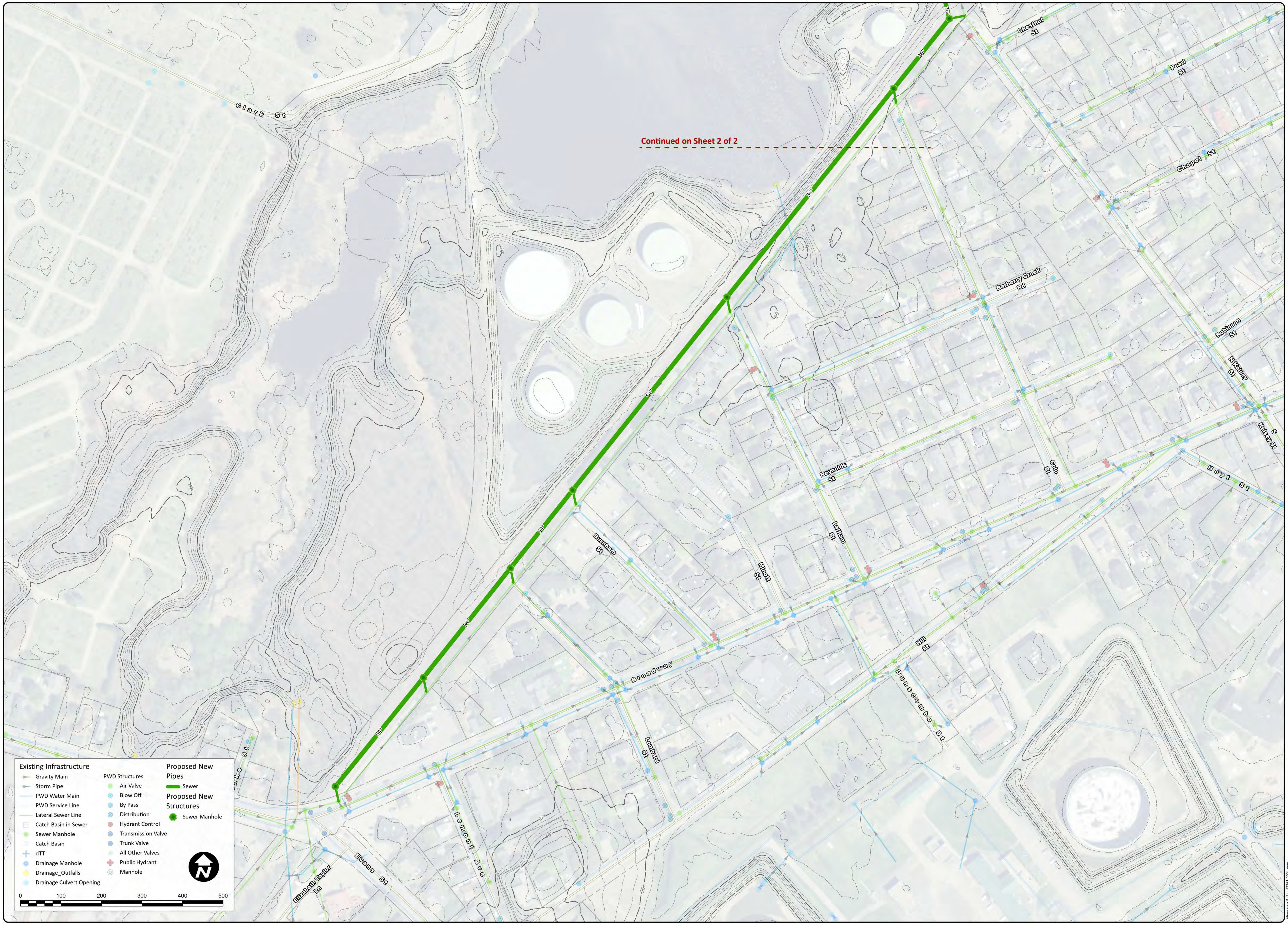
2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 50'
PROJECT	17351

SHEET 1 OF 1

Alternative 2C - 17351-2021.aprx



EXTERNAL DATA SOURCES
2018 orthoRegional Imagery
City of South Portland
Town of Cape Elizabeth

REV:	BY:	DATE:	STATUS:

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APPENDIX C-3 — ALTERNATIVE 8

OF:

2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 100'
PROJECT	17351

SHEET 1 OF 2

EXTERNAL DATA SOURCES
2018 ortho/Regional Imagery
City of South Portland
Town of Cape Elizabeth

REV:	BY:	DATE:	STATUS:

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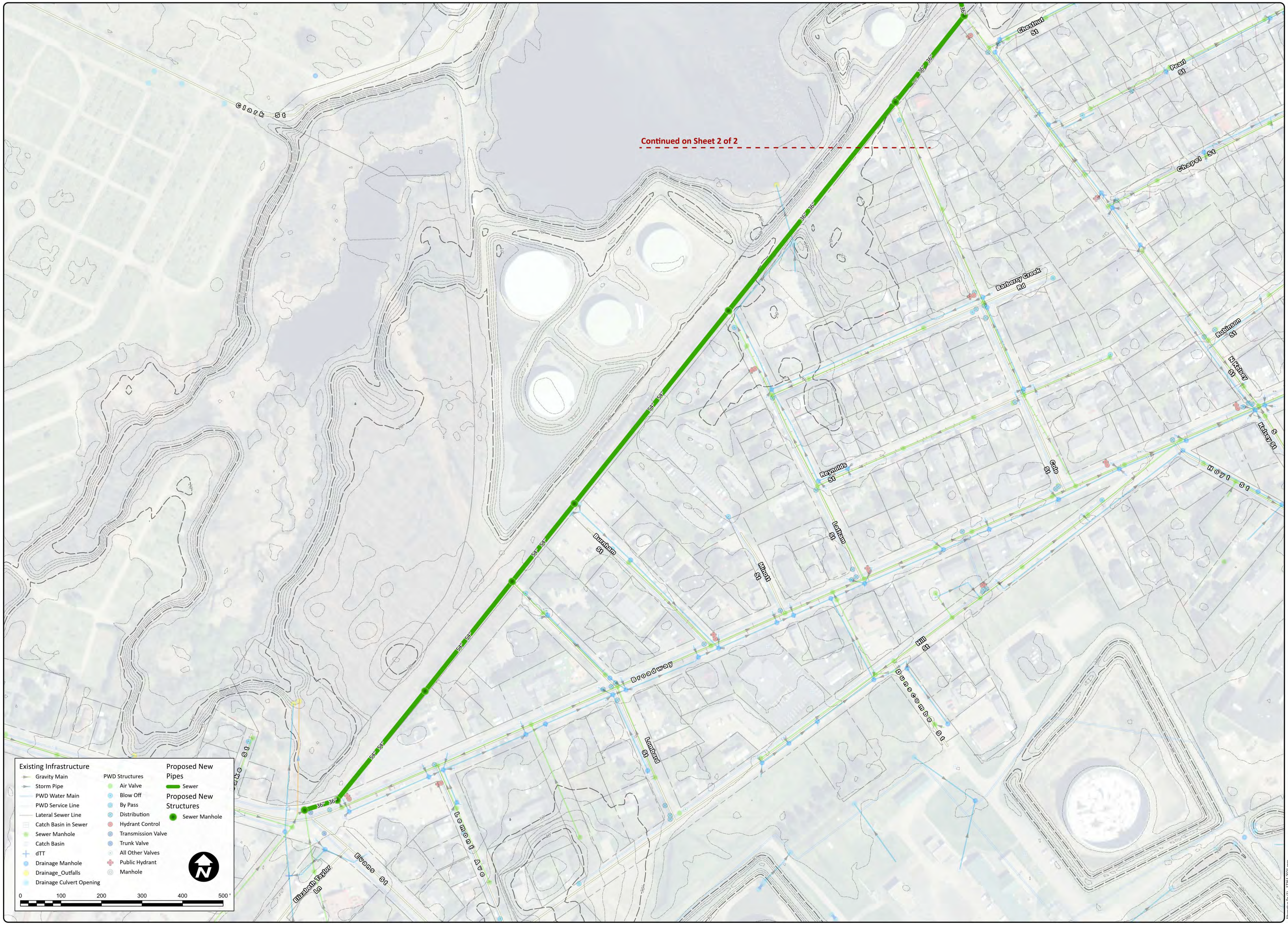
APPENDIX C-3 — ALTERNATIVE 8

OF:

2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 100'
PROJECT	17351



EXTERNAL DATA SOURCES

2018 orthoRegional Imagery
City of South Portland
Town of Cape Elizabeth

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APPENDIX C-4 — ALTERNATIVE 9A

OF:

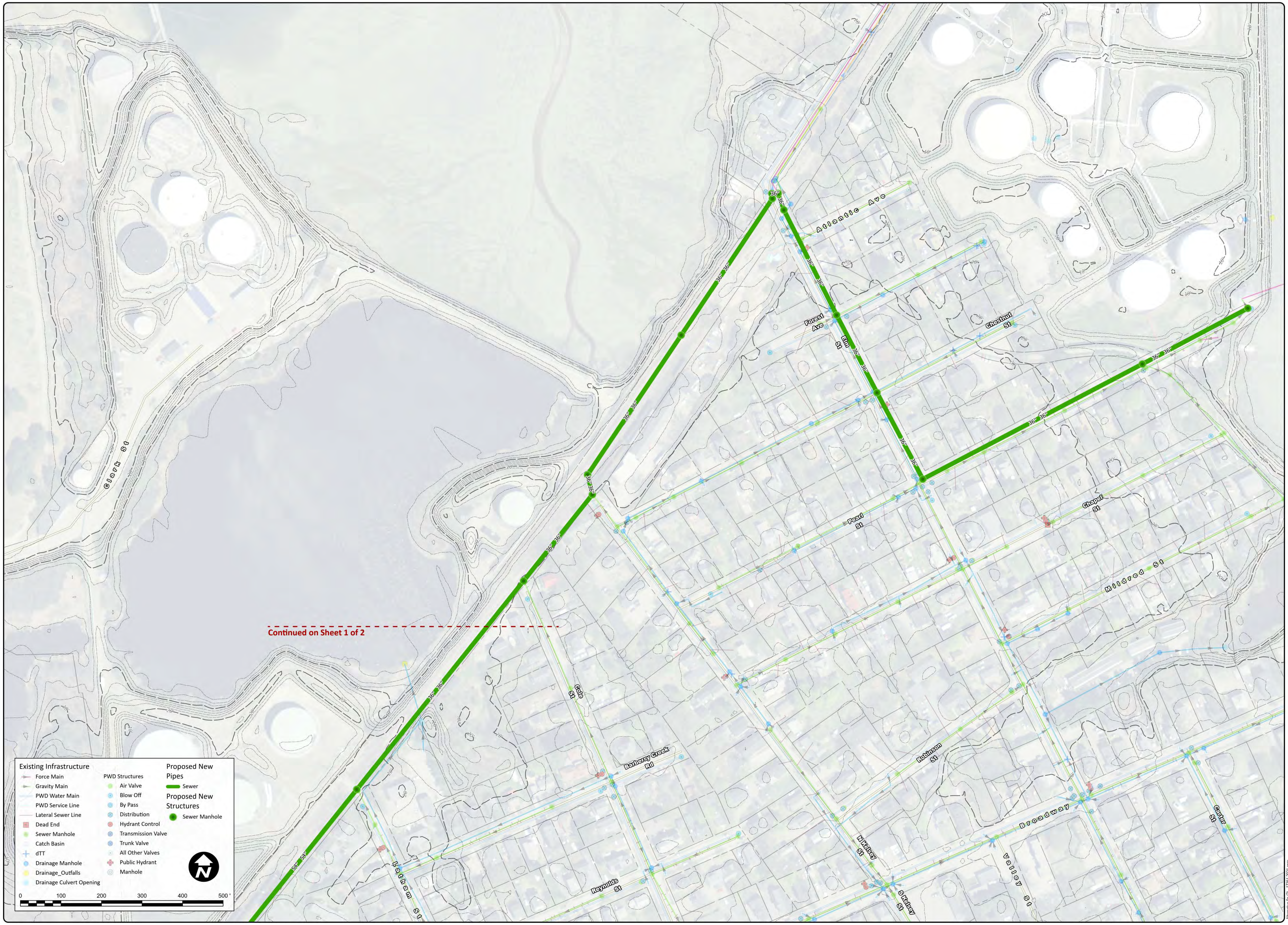
2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 100'
PROJECT	17351

Alternative 9a (1) - 17351-2021.aprx

SHEET 1 OF 2



EXTERNAL DATA SOURCES

2018 orthoRegional Imagery
City of South Portland
Town of Cape Elizabeth

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APPENDIX C-4 — ALTERNATIVE 9A

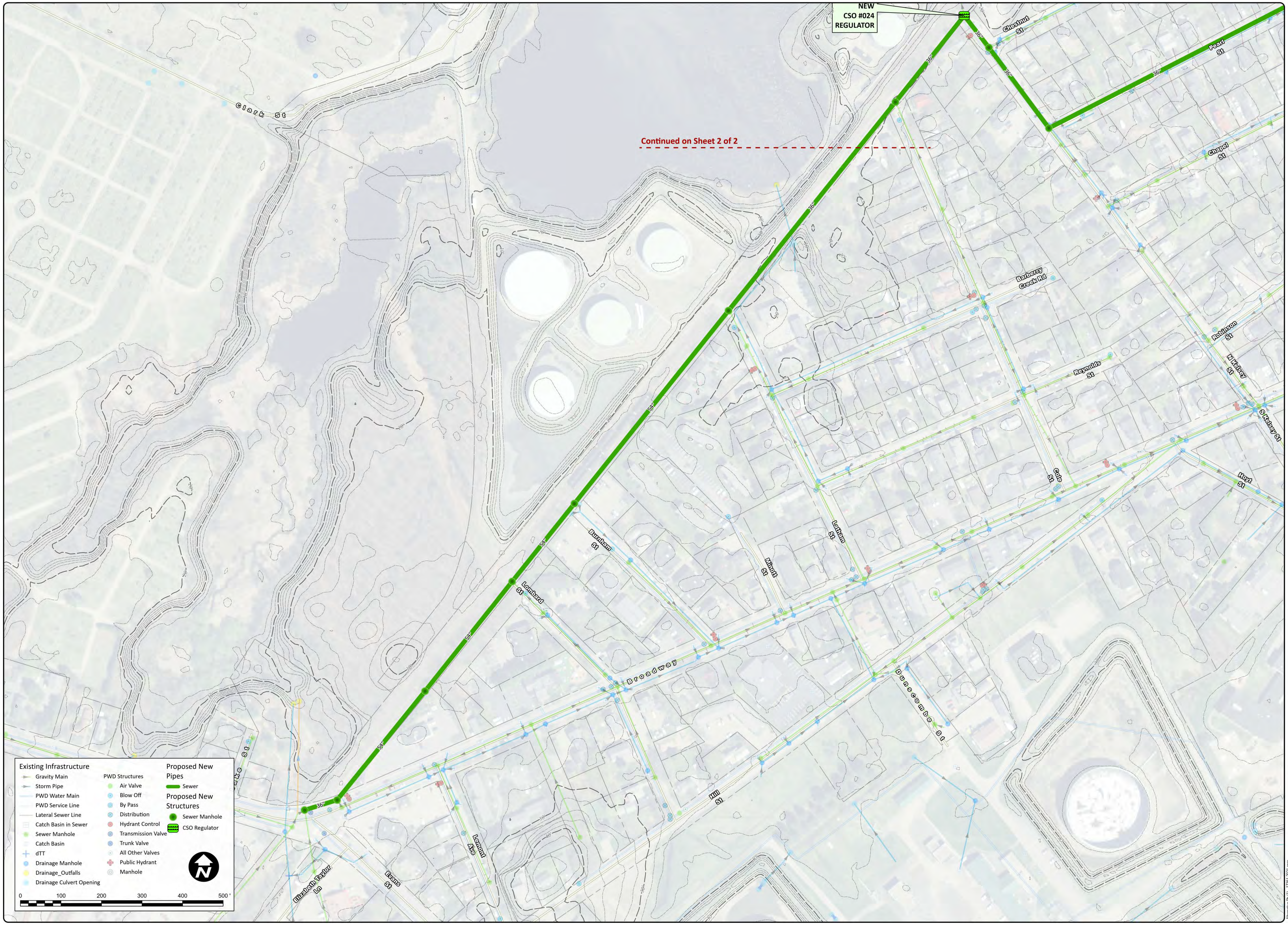
OF:

2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 100'
PROJECT	17351

Alternative 9a (2) - 17351-2021.aprx



EXTERNAL DATA SOURCES
2018 ortho/Regional Imagery
City of South Portland
Town of Cape Elizabeth

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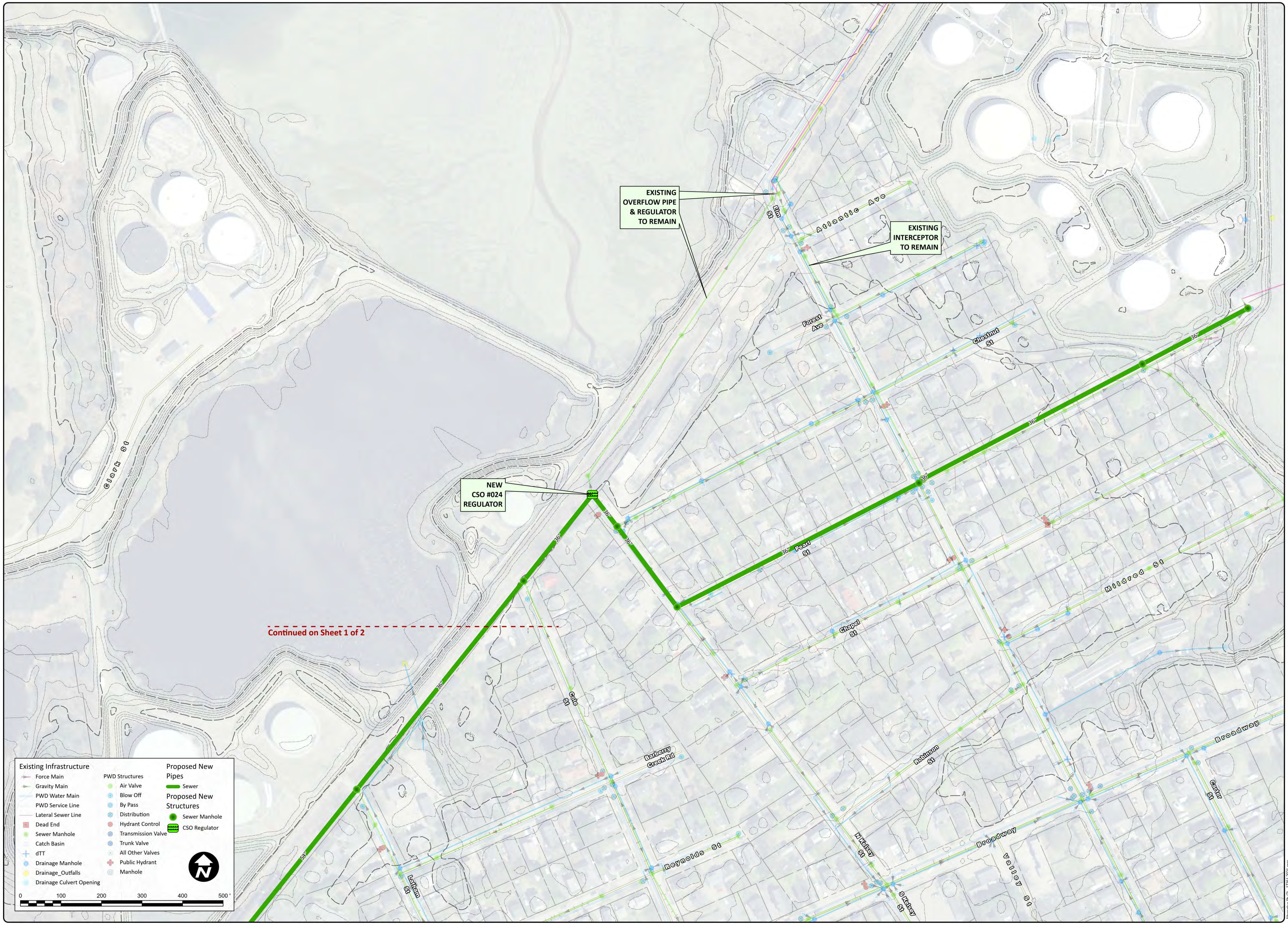
APPENDIX C-5 — ALTERNATIVE 9B

OF:

2021 CSO FACILITY PLAN UPDATE
CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 100'
PROJECT	17351

SHEET 1 OF 2



EXTERNAL DATA SOURCES
2018 ortho/Regional Imagery
City of South Portland
Town of Cape Elizabeth

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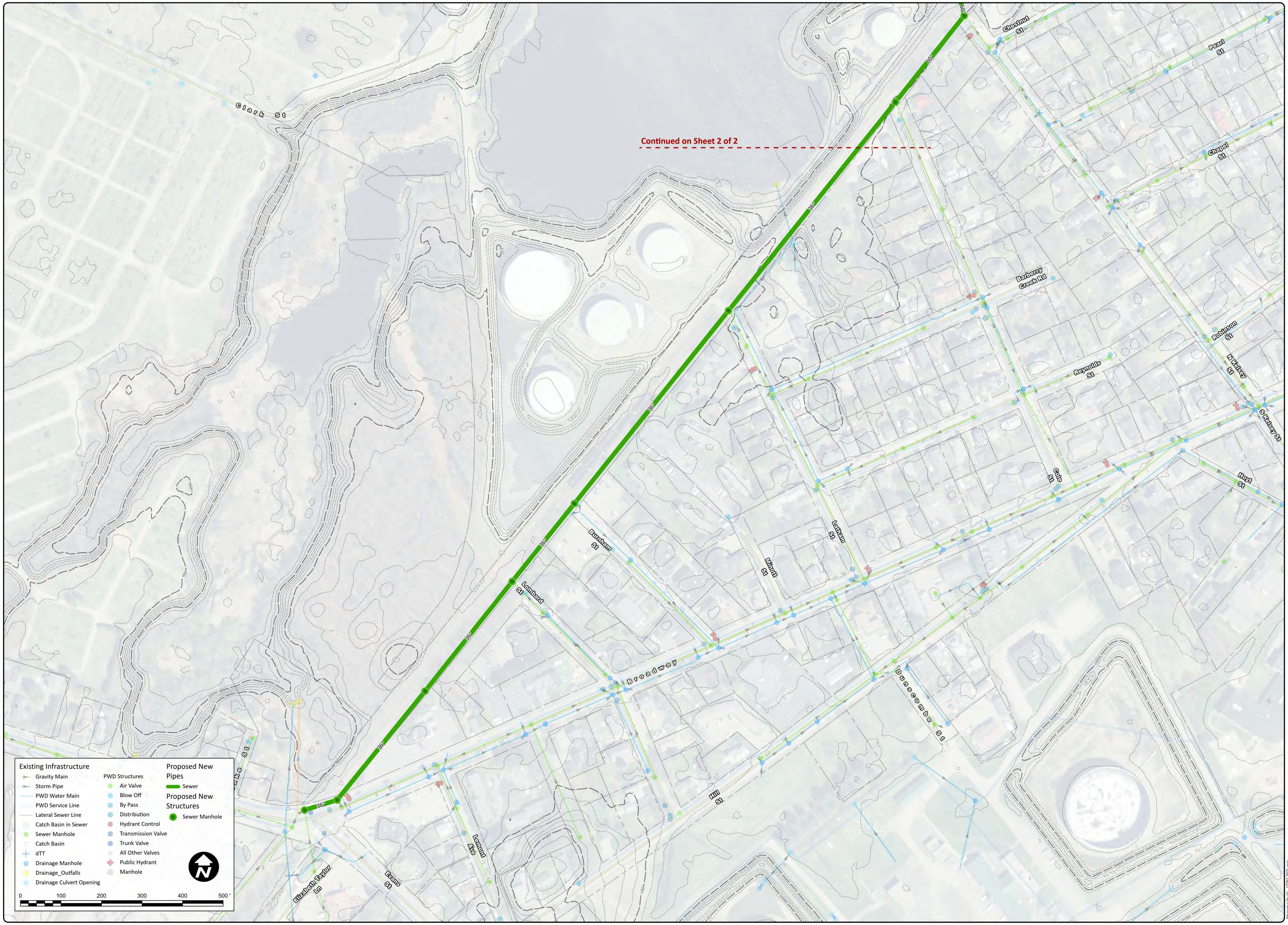
APPENDIX C-5 — ALTERNATIVE 9B

OF:

2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 100'
PROJECT	17351



Continued on Sheet 2 of 2

EXTERNAL DATA SOURCES

2018 orthoRegional Imagery
City of South Portland
Town of Cape Elizabeth

REV:	BY:	DATE:	STATUS:

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APPENDIX C-6 — ALTERNATIVE 9C

OF:

2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 100'
PROJECT	17351

Alternative 9c (1) - 17351-2021.aprx

SHEET 1 OF 2

EXTERNAL DATA SOURCES

2018 orthoRegional Imagery
City of South Portland
Town of Cape Elizabeth

REV:	BY:	DATE:	STATUS:

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APPENDIX C-6 — ALTERNATIVE 9C

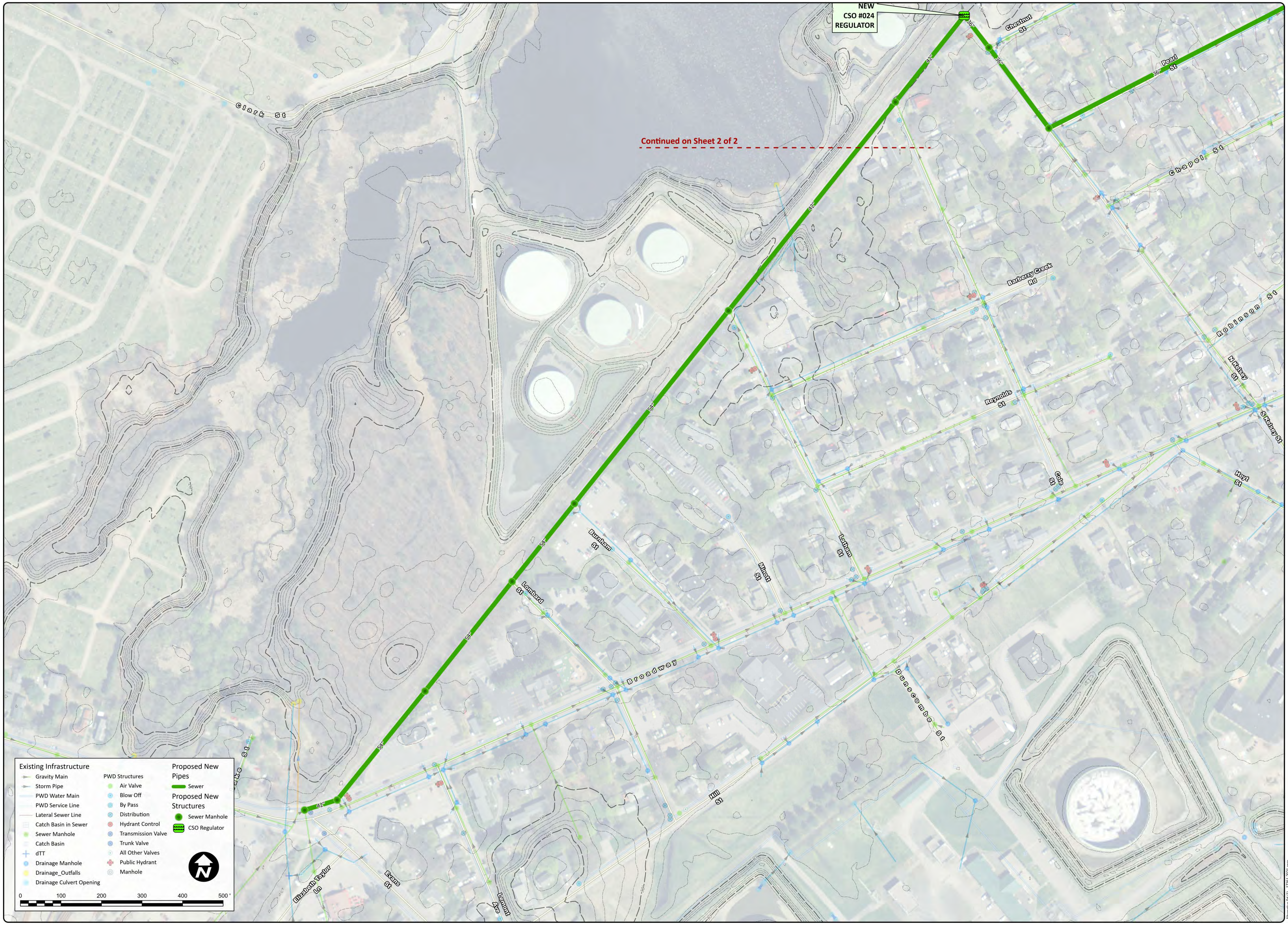
OF:

2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 100'
PROJECT	17351

Alternative 9c (2) - 17351-2021.aprx



EXTERNAL DATA SOURCES

2018 orthoRegional Imagery
City of South Portland
Town of Cape Elizabeth

REV:	BY:	DATE:	STATUS:

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APPENDIX C-5 — ALTERNATIVE 9D

OF:

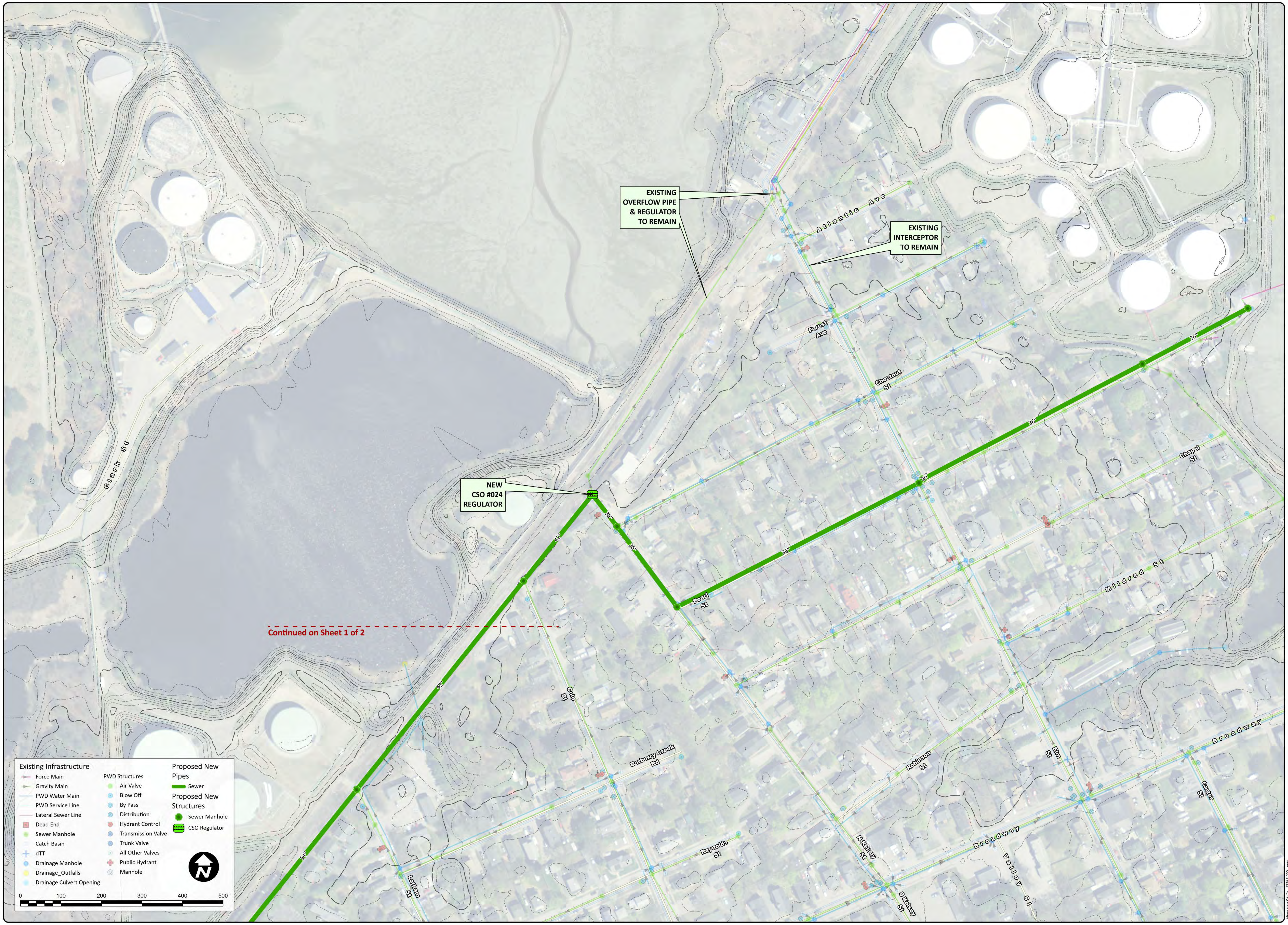
2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 100'
PROJECT	17351

SHEET 1 OF 2

Alternative 9d (1) - 17351-2021.aprx



EXTERNAL DATA SOURCES

2018 orthoRegional Imagery
City of South Portland
Town of Cape Elizabeth

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APPENDIX C-5 — ALTERNATIVE 9D

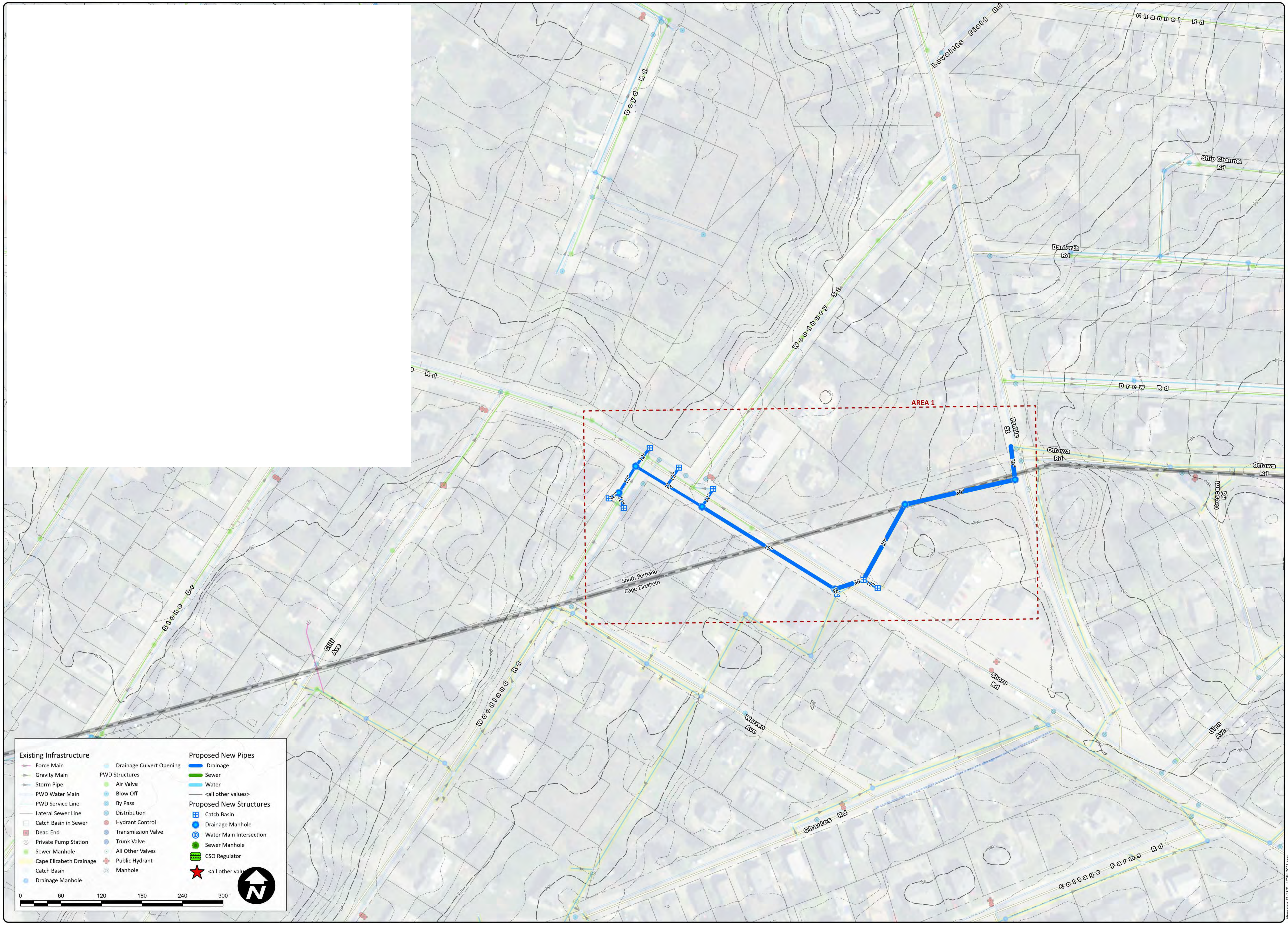
OF:

2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 100'
PROJECT	17351

Alternative 9d (2) - 17351-2021.aprx



EXTERNAL DATA SOURCES
2018 orthoRegional Imagery
City of South Portland
Town of Cape Elizabeth

REV:	BY:	DATE:	STATUS:

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APPENDIX C-7 — ALTERNATIVE 13 AREA 1

OF:

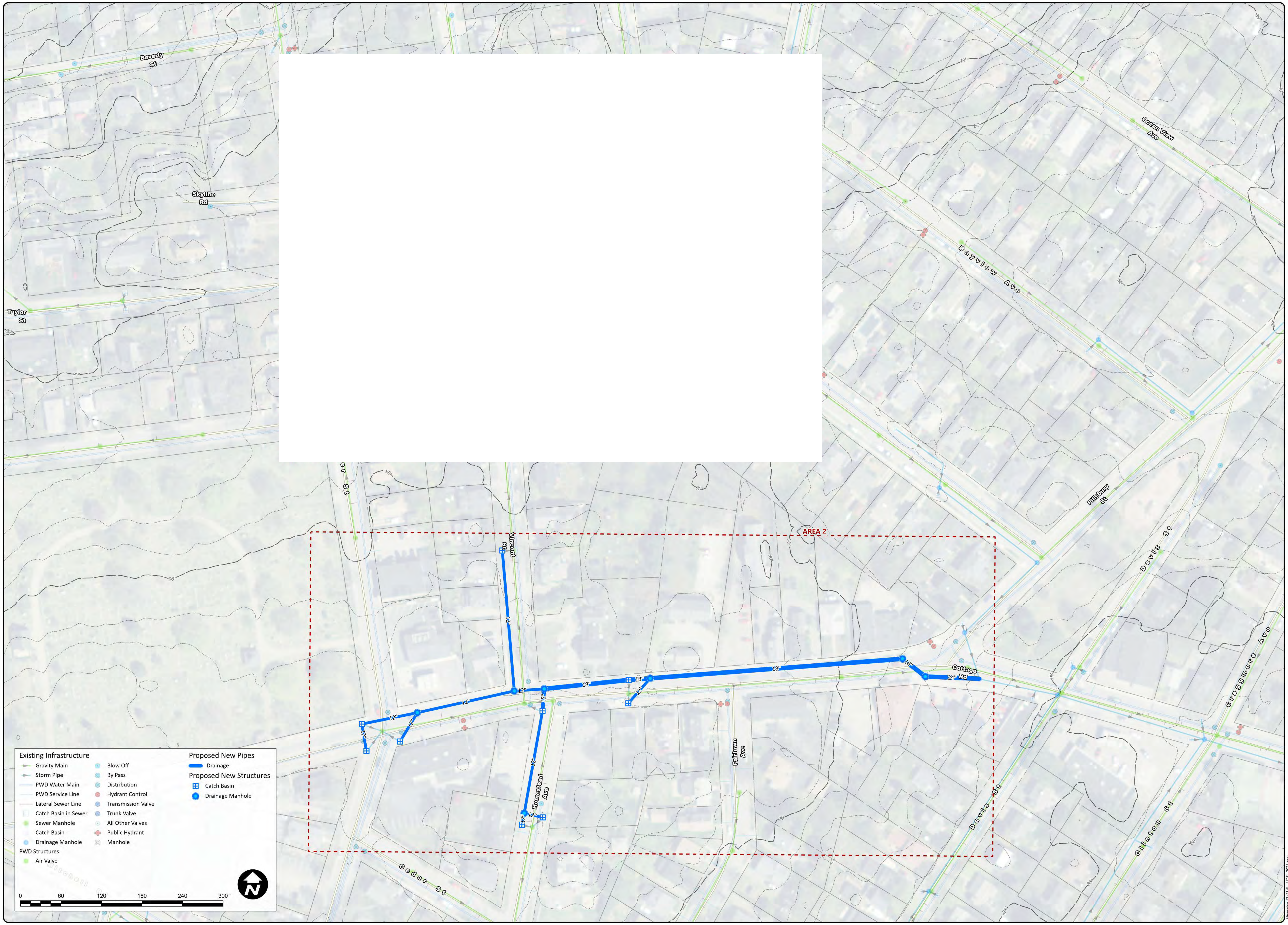
2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 60'
PROJECT	17351

SHEET 1 OF 2

Alternative 13 (1&2) - 17351-2021.aprx



Alternative 13 (3&4) - 17351-2021.aprx

EXTERNAL DATA SOURCES

2018 orthoRegional Imagery
City of South Portland
Town of Cape Elizabeth

REV:	BY:	DATE:	STATUS:

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APPENDIX C-7 — ALTERNATIVE 13 AREA 3

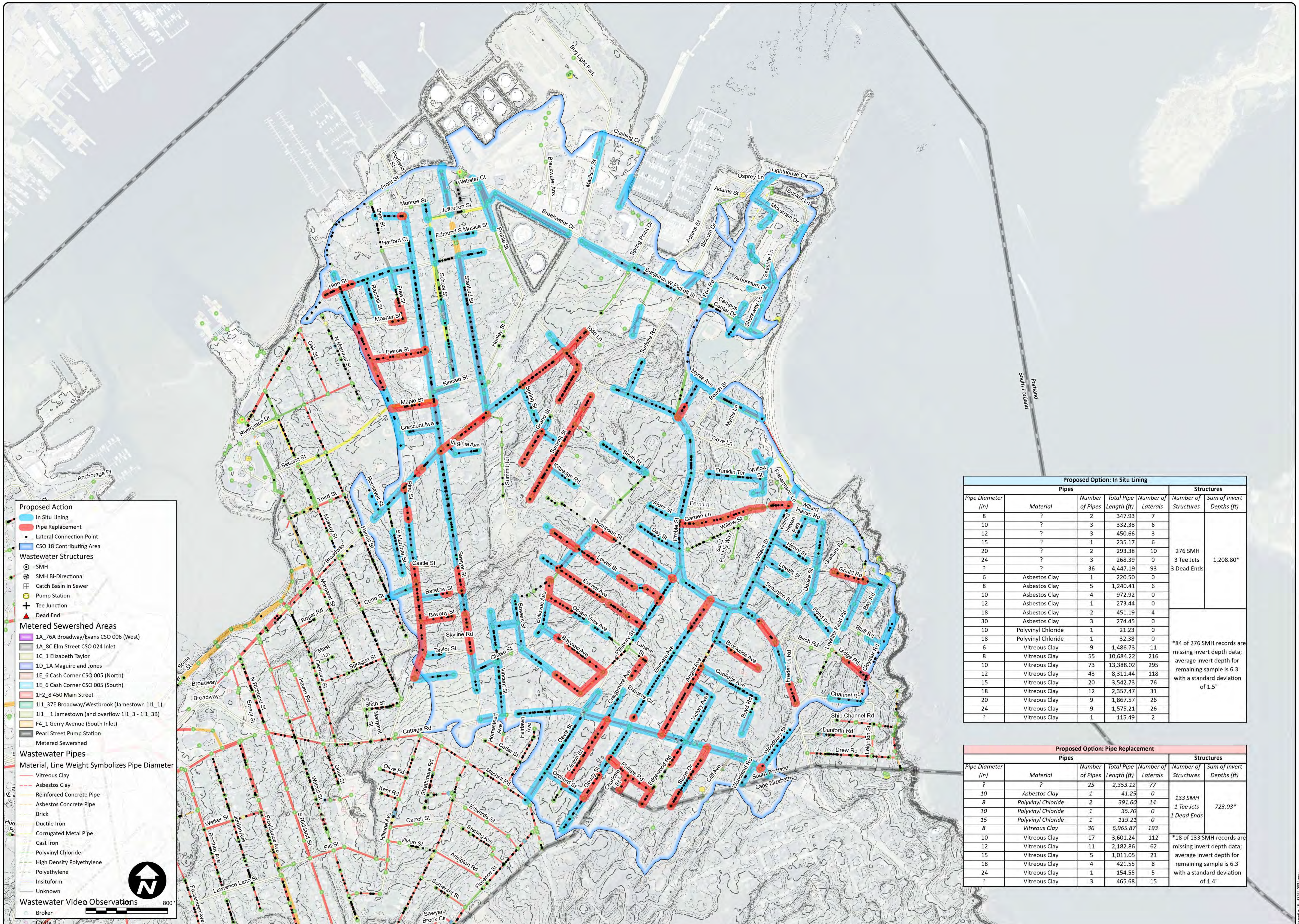
OF:

2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 60'
PROJECT	17351

SHEET 2 OF 2



Proposed Option: In Situ Lining						
Pipes					Structures	
Pipe Diameter (in)	Material	Number of Pipes	Total Pipe Length (ft)	Number of Laterals	Number of Structures	Sum of Invert Depths (ft)
8	?	2	347.93	7	276 SMH 3 Tee Jcts 3 Dead Ends	1,208.80*
10	?	3	332.38	6		
12	?	3	450.66	3		
15	?	1	235.17	6		
20	?	2	293.38	10		
24	?	3	268.39	0		
?	?	36	4,447.19	93		
6	Asbestos Clay	1	220.50	0		
8	Asbestos Clay	5	1,240.41	6		
10	Asbestos Clay	4	972.92	0		
12	Asbestos Clay	1	273.44	0		
18	Asbestos Clay	2	451.19	4	*84 of 276 SMH records are missing invert depth data; average invert depth for remaining sample is 6.3' with a standard deviation of 1.5'	
30	Asbestos Clay	3	274.45	0		
10	Polyvinyl Chloride	1	21.23	0		
18	Polyvinyl Chloride	1	32.38	0		
6	Vitreous Clay	9	1,486.73	11		
8	Vitreous Clay	55	10,684.22	216		
10	Vitreous Clay	73	13,388.02	295		
12	Vitreous Clay	43	8,311.44	118		
15	Vitreous Clay	20	3,542.73	76		
18	Vitreous Clay	12	2,357.47	31		
20	Vitreous Clay	9	1,867.57	26		
24	Vitreous Clay	9	1,575.21	26		
?	Vitreous Clay	1	115.49	2		

Proposed Option: Pipe Replacement						
Pipes					Structures	
Pipe Diameter (in)	Material	Number of Pipes	Total Pipe Length (ft)	Number of Laterals	Number of Structures	Sum of Invert Depths (ft)
?	?	25	2,353.12	77	133 SMH 1 Tee Jcts 1 Dead Ends	723.03*
10	Asbestos Clay	1	41.25	0		
8	Polyvinyl Chloride	2	391.60	14		
10	Polyvinyl Chloride	1	35.70	0		
15	Polyvinyl Chloride	1	119.21	0		
8	Vitreous Clay	36	6,965.87	193		
10	Vitreous Clay	17	3,601.24	112	*18 of 133 SMH records are missing invert depth data; average invert depth for remaining sample is 6.3' with a standard deviation of 1.4'	
12	Vitreous Clay	11	2,182.86	62		
15	Vitreous Clay	5	1,011.05	21		
18	Vitreous Clay	4	421.55	8		
24	Vitreous Clay	1	154.55	5		
?	Vitreous Clay	3	465.68	15		

EXTERNAL DATA SOURCES
2021 orthoRegional Imagery
City of South Portland
ESRI Basemap

REV:	BY:	DATE:	STATUS:

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South Portland, ME 04106
Tel. 207-200-2100

APPENDIX C-8 — ALTERNATIVE 15

OF:

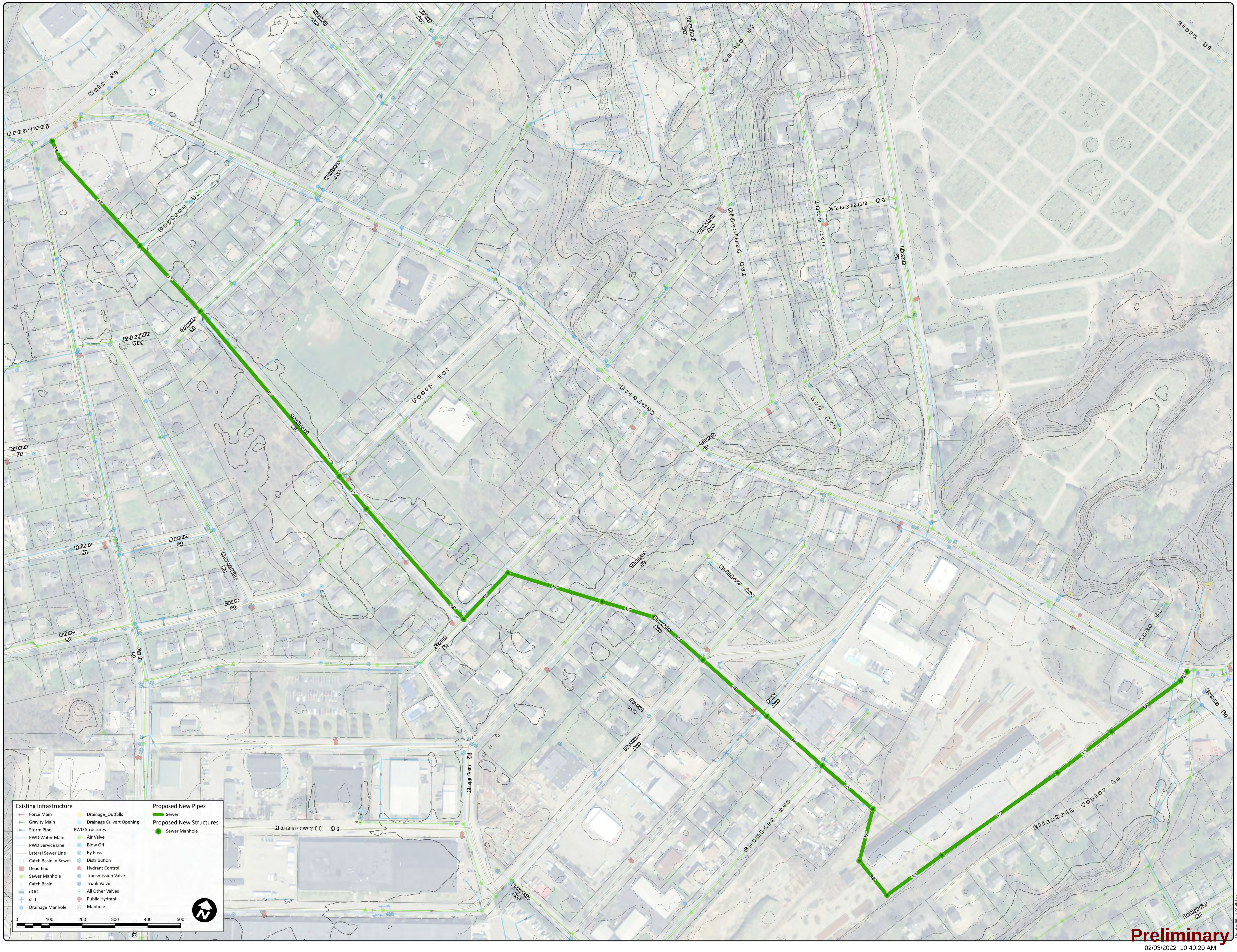
2021 CSO FACILITY PLAN UPDATE

CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	9/3/2021
SCALE	1" = 400'
PROJECT	17351

Alternative 15 - 17351-2021.aprx

SHEET 1 OF 1



Preliminary
02/03/2022 10:40:20 AM

EXTERNAL DATA SOURCES
2018 orthoRegional Imagery
City of South Portland
Town of Cape Elizabeth

NOTES:

REV:	BY:	DATE:	STATUS:

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APPENDIX C-9 – ALTERNATIVE 16
OF:
2021 CSO FACILITY PLAN UPDATE
CITY OF SOUTH PORTLAND, MAINE

DESIGNED	CPT
DRAWN	JLH
CHECKED	DLR
DATE	2/3/2022
SCALE	1" = 100'
PROJECT	17351

SHEET 1 OF 1

Alternative 16A - 17351-2021.aprx

APPENDIX D: CONCEPTUAL COST ESTIMATE BREAKDOWNS

South Portland Facilities Management Plan Update - Alternative 1

Alternative 1 Renewal Area 1

Item	Unit	Quantity	Cost		Item Total		Note
Lining/Rehabilitation 6" and 8"	LF	500	$	65	$	32,500.0	Currrent South Portland rates
Lining/Rehabilitation 10"	LF	10780	$	72	$	776,160.0	
Lining/Rehabilitation 12"	LF	2850	$	80	$	228,000.0	
Lining/Rehabilitation 15"	LF	82	$	140	$	11,480.0	
Line Manholes	EA	68	$	275	$	18,700.0	
Replace 8" Sewer	LF	280	$	126	$	35,280.0	
Replace 10" Sewer	LF	3400	$	138	$	469,200.0	
Replace 24" Sewer	LF	2250	$	300	$	675,000.0	
Replace Manholes	EA	34	$	6,200	$	210,800.0	
Bypass Pumping Mobilization	LS	1	$	40,000	$	40,000.0	
Bypass Pumping	Month	6	$	50,000	$	300,000.0	
Road Restoration (Trench Repair)	LF	3680	$	43	$	158,240.0	
			Subtotal		$	2,955,360.0	
CCTV Inspection/Assessments	LF	20142	$	5	$	100,710.0	Estimated, no basis assumes video must be performed
Engineering (Design, Permitting & CA)	LS			20%	$	591,072.0	
Misc/Incidentals				25%	$	738,840.0	
Contingency				10%	$	295,536.0	
	Year		Total		$	4,681,518.0	2021 cost
Cost Escalation	**2022**	**6%**			**$**	**4,962,409.08**	Ongoing Annual Program

Alternative 1 Renewal Area 2

Item	Unit	Quantity	Cost		Item Total		Note
Lining/Rehabilitation 6" and 8"	LF		$	65	$	-	Currrent South Portland rates
Lining/Rehabilitation 10"	LF	1680	$	72	$	120,960.0	
Lining/Rehabilitation 12"	LF	1000	$	80	$	80,000.0	
Lining/Rehabilitation 18"	LF	3270	$	141	$	461,070.0	
Line Manholes	EA	29	$	275	$	7,975.0	
Replace 8" Sewer	LF		$	126	$	-	
Replace 10" Sewer	LF	168	$	138	$	23,184.0	Assume 10% for spot repairs
Replace 12" Sewer	LF	100	$	162	$	16,200.0	Assume 10% for spot repairs
Replace 18" Sewer	LF	327	$	240	$	78,480.0	Assume 10% for spot repairs
Replace Manholes	EA	3	$	6,200	$	18,600.0	Assume 10% for spot repairs
Bypass Pumping Mobilization	LS	1	$	40,000	$	40,000.0	
Bypass Pumping	Month	6	$	50,000	$	300,000.0	
Road Restoration (Trench Repair)	LF	168	$	43	$	7,224.0	
			Subtotal		$	1,153,693.0	
CCTV Inspection/Assessments	LF	5950	$	6	$	35,700.0	Estimated, no basis, assumeds video must be perfornmed
Engineering (Design, Permitting & CA)	LS			20%	$	230,738.6	
Misc/Incidentals				25%	$	288,423.3	
Contingency				10%	$	115,369.30	
			Total		$	1,708,554.9	2021 cost
Cost Escalation	**2022**	**6%**			**$**	**1,811,068.14**	Ongoing Annual Program

South Portland Facilities Management Plan Update - Alternative 1

Alternative Renewal Area 3

Item	Unit	Quantity	Cost	Item Total	Note
Lining/Rehabilitation 6" and 8"	LF	1280	$ 65	$ 83,200.0	Currrent South Portland rates
Lining/Rehabilitation 10"	LF	2170	$ 72	$ 156,240.0	
Lining/Rehabilitation 12"	LF	4184	$ 80	$ 334,720.0	
Lining/Rehabilitation 15"	LF		$ 140	$ -	
Lining/Rehabilitation 18"	LF		$ 141	$ -	
Line Manholes	EA	36	$ 275	$ 9,900.0	
Replace 8" Sewer	LF		$ 126	$ -	
Replace 10" Sewer	LF	1460	$ 138	$ 201,480.0	
Replace 12" Sewer	LF	506	$ 162	$ 81,972.0	
Replace 15" Sewer	LF	1000	$ 220	$ 220,000.0	
Replace 18" Sewer	LF	200	$ 240	$ 48,000.0	
Replace Manholes	EA	19	$ 6,200	$ 117,800.0	
Bypass Pumping Mobilization	LS	1	$ 40,000	$ 40,000.0	
Bypass Pumping	Month	6	$ 50,000	$ 300,000.0	
Road Restoration (Trench Repair)	LF	1966	$ 43	$ 84,538.0	
			Subtotal	$ 1,677,850.0	
CCTV Inspection/Assessments	LF	9600	$ 5	$ 48,000.0	Estimated, no basis, assumeds video must be perfornmed
Engineering (Design, Permitting & CA)	LS		20%	$ 335,570.0	
Misc/Incidentals			25%	$ 419,462.5	
Contingency			10%	$ 167,785.00	
			Total	$ 2,480,882.5	2021 cost
Cost Escalation	**2022**	**6%**		**$ 2,629,735.45**	Ongoing Annual Program

South Portland Facilities Management Plan Update - Alternative 2

Alternative 2A

Item	Unit	Quantity	Cost		Item Total		Note
12" Storm Drain	LF	690	$	158	$	109,020	
15" Storm Drain	LF	220	$	182	$	40,040	
18" Storm Drain	LF	230	$	197	$	45,310	
24" Storm Drain	LF	430	$	264	$	113,520	
30" Storm Drain	LF		$	300	$	-	
4' Catch Basins	EA	10	$	6,100	$	61,000	
4' Drain Manholes	EA	4	$	6,200	$	24,800	
5' Drain Manholes	EA	4	$	9,000	$	36,000	
Watermain relocation	LF	315	$	465	$	146,475	
Gas relocation	LF	315	$	312	$	98,280	
8" Sanitary Sewer	LF	385	$	126	$	48,510	
4' Sewer Manhole	EA	4	$	6,200	$	24,800	
Curb and Sidewalk	LF	730	$	67	$	48,910	
Road Restoration	SY	5900	$	48	$	283,200	
Outfalls	EA	1	$	20,000	$	20,000	
Broadway Crossing (Pipe Cost Premium)	LF	150	$	600	$	90,000	
Traffic Signal Allowance at Broadway	LS	1	$	75,000	$	75,000	
Ledge Allowance	CY	581	$	250	$	145,370	
			Subtotal		$	1,410,235	
Engineering (Design, Permitting & CA)				20%	$	282,047	
Misc/Incidentals				25%	$	352,559	
Contingency				10%	$	141,024	
			Total		$	2,185,865	
Cost Escalation	**2022**	**6%**			**$**	**2,317,016.71**	

South Portland Facilities Management Plan Update - Alternative 2

Alternative 2B Peary Terrace Storage Option

Item	Unit	Quantity	Cost		Item Total		Note
12" Storm Drain	LF	730	$	158	$	115,340	
15" Storm Drain	LF		$	182	$	-	
18" Storm Drain	LF	390	$	197	$	76,830	
24" Storm Drain	LF	170	$	264	$	44,880	
30" Storm Drain	LF	150	$	300	$	45,000	
4' Catch Basins	EA	12	$	6,100	$	73,200	
5' Catch Basins	EA	4	$	6,200	$	24,800	
5' Drain Manholes	EA		$	9,000	$	-	
6' Drain Manholes	EA	2	$	12,150	$	24,300	
Watermain relocation	LF	180	$	465	$	83,700	
Gas relocation	LF	180	$	312	$	56,160	
8" Sanitary Sewer	LF	200	$	126	$	25,200	
4' Sewer Manhole	EA	2	$	6,200	$	12,400	
Curb and Sidewalk	LF		$	67	$	-	
Road Restoration	SY	5000	$	48	$	240,000	
Storage Facilty	EA	1	$	350,000	$	350,000	
Land Aqusition Allowance	LS	1	$	250,000	$	250,000	
Ledge Allowance	CY	810	$	250	$	202,500	
			Subtotal		$	1,624,310	
Engineering (Design, Permitting & CA)				20%	$	324,862	
Misc/Incidentals				25%	$	406,078	
Contingency				10%	$	162,431	
			Total		$	2,517,681	
Cost Escalation	**2022**	**6%**			**$**	**2,668,741.33**	

South Portland Facilities Management Plan Update - Alternative 2

Alternative 2C

Item	Unit	Quantity	Cost	Item Total	Note
12" Storm Drain	LF	1500	$ 158	$ 237,000	
15" Storm Drain	LF	80	$ 182	$ 14,560	
18" Storm Drain	LF	315	$ 197	$ 62,055	
24" Storm Drain	LF	430	$ 264	$ 113,520	
30" Storm Drain	LF	100	$ 300	$ 30,000	
4' Catch Basins	EA	15	$ 6,100	$ 91,500	
4' Drain Manholes	EA	4	$ 6,200	$ 24,800	
5' Drain Manholes	EA	4	$ 9,000	$ 36,000	
Watermain relocation	LF	310	$ 465	$ 144,150	
Gas relocation	LF	310	$ 312	$ 96,720	
8" Sanitary Sewer	LF	645	$ 126	$ 81,270	
4' Sewer Manhole	EA	6	$ 6,200	$ 37,200	
Curb and Sidewalk	LF	1210	$ 67	$ 81,070	
Road Restoration	SY	12400	$ 48	$ 595,200	
Outfalls	EA	1	$ 20,000	$ 20,000	
Broadway Crossing (Pipe Cost Premium)	LF	300	$ 600	$ 180,000	
Traffic Signal Allowance at Broadway	LS	1	$ 75,000	$ 75,000	
Ledge Allowance	CY	898	$ 250	$ 224,537	
			Subtotal	$ 2,144,582	
Engineering (Design, Permitting & CA)			20%	$ 428,916	
Misc/Incidentals			25%	$ 536,146	
Contingency			10%	$ 214,458	
			Total	$ 3,324,102	
Cost Escalation	**2022**	**6%**		**$ 3,523,548.29**	

South Portland Facilities Management Plan Update - Alternative 2

Alternative 2D

Item	Unit	Quantity	Cost	Item Total	Note
12" Storm Drain	LF	1710	$ 158	$ 270,180	
15" Storm Drain	LF	225	$ 182	$ 40,950	
18" Storm Drain	LF	1360	$ 197	$ 267,920	
24" Storm Drain	LF	320	$ 264	$ 84,480	
30" Storm Drain	LF	500	$ 300	$ 150,000	
36" Storm Drain	LF	560	$ 360	$ 201,600	
4' Catch Basins	EA	30	$ 6,100	$ 183,000	
4' Drain Manholes	EA	9	$ 6,200	$ 55,800	
5' Drain Manholes	EA	4	$ 9,000	$ 36,000	
6' Drain Manholes	EA	4	$ 12,150	$ 48,600	
Watermain relocation	LF	1100	$ 465	$ 511,500	
Gas relocation	LF	1100	$ 312	$ 343,200	
8" Sanitary Sewer	LF	520	$ 126	$ 65,520	
4' Sewer Manhole	EA	6	$ 6,200	$ 37,200	
Curb and Sidewalk	LF	2000	$ 67	$ 134,000	
Road Restoration	SY	17400	$ 48	$ 835,200	
Outfalls	EA	1	$ 20,000	$ 20,000	
Cross Country (Pipe Cost Premium)	LF	600	$ 500	$ 300,000	
Land Aqusition Allowance	LS	1	$ 500,000	$ 500,000	
Ledge Allowance	CY	2286	$ 250	$ 571,528	
			Subtotal	$ 4,656,678	
Engineering (Design, Permitting & CA)			20%	$ 931,336	
Misc/Incidentals			25%	$ 1,164,169	
Contingency			10%	$ 465,668	
			Total	$ 7,217,851	
Cost Escalation	**2022**	**6%**		**$ 7,650,921.59**	

South Portland Facilities Management Plan Update - Alternative 8

Alternative 8

Item	Unit	Quantity	Cost		Item Total		Note
36" Sewer	LF	2810	$	360	$	1,011,600	
36" Sewer >15' Deep	LF	500	$	720	$	360,000	
54" Sewer	LF		$	720	$	-	
60" Sewer	LF		$	780	$	-	
Jack and Bore 36" Broadway	LF	175	$	780	$	136,500	
6' Manholes	EA	18	$	12,150	$	218,700	
8' Manholes	EA		$	19,000	$	-	
Special Manholes (Pile Supported)	EA	2	$	74,750	$	149,500	
Helical Pile Mobilization/Design/Testing	LS	1	$	71,500	$	71,500	
Helical Piles	LF	400	$	50	$	20,000	
Jacking Pits	EA	4	$	111,000	$	444,000	
12" Stormdrain Reconstruction	LF		$	158	$	-	
18" Stormdrain Reconstruction	LF		$	197	$	-	
24" Stormdrain Reconstruction	LF		$	264	$	-	
30" Stormdrain Reconstruction	LF		$	300	$	-	
Reconstruct 4' Drain Manhole or Catch Bas	EA		$	6,200	$	-	
Reconstruct 5' Drain Manhole or Catch Bas	EA		$	9,000	$	-	
Reconstruct 6' Drain Manhole or Catch Bas	EA		$	12,150	$	-	
Watermain relocation	LF	465	$	465	$	216,225	
Gas relocation	LF	325	$	312	$	101,400	
CSO Structure	EA	1	$	100,000	$	100,000	
8" Sanitary Sewer	LF		$	126	$	-	
4' Sewer Manhole	EA		$	6,200	$	-	
Curb and Sidewalk	LF	350	$	67	$	23,450	
Road Restoration	SY	6500	$	48	$	312,000	
Broadway Crossing (Pipe Cost Premium)	LF	200	$	600	$	120,000	
Traffic Signal Allowance at Broadway	LS	1	$	75,000	$	75,000	
Ledge Allowance	CY		$	250	$	-	
Unsiutable/Borrow Allowance	CY	2942	$	35	$	102,978	
Land Aqusition Allowance	LS	1	$	250,000	$	250,000	
Bypass Pumping Mobilization	LS	1	$	40,000	$	40,000	
Bypass Pumping	Month	7	$	50,000	$	350,000.0	
Rail Crossing (Private)	EA	0	$	300,000	$	-	
Rail Crossing (Signalized)	EA		$	500,000			
			Subtotal		$	3,359,875	
Engineering (Design, Permitting & CA)				20%	$	671,975	
Misc/Incidentals				25%	$	839,969	
Contingency				10%	$	335,988	
			Total		$	5,950,784	
Cost Escalation	**2022**	**6%**			**$**	**6,307,831.07**	

South Portland Facilities Management Plan Update - Alternative 9

Alternative 9A

Item	Unit	Quantity	Cost	Item Total	Note
36" Sewer	LF	2500	$ 360	$ 900,000	
36" Sewer >15' Deep	LF	1000	$ 720	$ 720,000	
54" Sewer	LF	1515	$ 720	$ 1,090,800	
60" Sewer	LF		$ 780	$ -	
Jack and Bore 36" Broadway, Rail at Kelsey	LF	175	$ 780	$ 136,500	
6' Manholes	EA	17	$ 12,150	$ 206,550	
8' Manholes	EA	5	$ 19,000	$ 95,000	
Special Manholes (Pile Supported)	EA	6	$ 74,750	$ 448,500	
Helical Pile Mobilization/Design/Testing	LS	1	$ 71,500	$ 71,500	
Helical Piles	LF	1200	$ 50	$ 60,000	
Jacking Pits	EA	4	$ 111,000	$ 444,000	
12" Stormdrain Reconstruction	LF	80	$ 158	$ 12,640	
18" Stormdrain Reconstruction	LF	80	$ 197	$ 15,760	
24" Stormdrain Reconstruction	LF	200	$ 264	$ 52,800	
30" Stormdrain Reconstruction	LF	350	$ 300	$ 105,000	
Reconstruct 4' Drain Manhole or Catch Basi	EA	4	$ 6,200	$ 24,800	
Reconstruct 5' Drain Manhole or Catch Basi	EA	1	$ 9,000	$ 9,000	
Reconstruct 6' Drain Manhole or Catch Basi	EA	7	$ 12,150	$ 85,050	
Watermain relocation	LF	915	$ 465	$ 425,475	
Gas relocation	LF	915	$ 312	$ 285,480	
CSO Structure	EA	2	$ 100,000	$ 200,000	
8" Sanitary Sewer	LF	200	$ 126	$ 25,200	
4' Sewer Manhole	EA	2	$ 6,200	$ 12,400	
Curb and Sidewalk	LF	1200	$ 67	$ 80,400	
Road Restoration	SY	8800	$ 48	$ 422,400	
Broadway Crossing (Pipe Cost Premium)	LF	200	$ 600	$ 120,000	
Traffic Signal Allowance at Broadway	LS	1	$ 75,000	$ 75,000	
Ledge Allowance	CY		$ 250	$ -	
Unsiutable/Borrow Allowance	CY	3500	$ 33	$ 115,500	
Land Aqusition Allowance	LS	1	$ 250,000	$ 250,000	
Bypass Pumping Mobilization	LS	1	$ 40,000	$ 40,000	
Bypass Pumping	Month	10	$ 50,000	$ 500,000.0	
Rail Crossing (Private)	EA	1	$ 300,000	$ 300,000.0	
Rail Crossing (Signalized)	EA		$ 500,000	$ -	
			Subtotal	$ 7,329,755	
Engineering (Design, Permitting & CA)			20%	$ 1,465,951	
Misc/Incidentals			25%	$ 1,832,439	
Contingency			10%	$ 732,976	
			Total	$ 11,361,120	
Cost Escalation	**2022**	**6%**		**$ 12,042,787.47**	

South Portland Facilities Management Plan Update - Alternative 9

Alternative 9B

Item	Unit	Quantity	Cost	Item Total	Note
36" Sewer	LF	1950	$ 360	$ 702,000	
36" Sewer >15' Deep	LF	925	$ 720	$ 666,000	
54" Sewer	LF	1515	$ 720	$ 1,090,800	
60" Sewer	LF		$ 780	$ -	
Jack and Bore 36" Broadway	LF	175	$ 780	$ 136,500	
6' Manholes	EA	12	$ 12,150	$ 145,800	
8' Manholes	EA	5	$ 19,000	$ 95,000	
Special Manholes (Pile Supported)	EA	5	$ 74,750	$ 373,750	
Helical Pile Mobilization/Design/Testing	LS	1	$ 71,500	$ 71,500	
Helical Piles	LF	1000	$ 50	$ 50,000	
Jacking Pits	EA	4	$ 111,000	$ 444,000	
12" Stormdrain Reconstruction	LF	500	$ 158	$ 79,000	
18" Stormdrain Reconstruction	LF	250	$ 197	$ 49,250	
24" Stormdrain Reconstruction	LF		$ 264	$ -	
30" Stormdrain Reconstruction	LF		$ 300	$ -	
Reconstruct 4' Drain Manhole or Catch Basi	EA	16	$ 6,200	$ 99,200	
Reconstruct 5' Drain Manhole or Catch Basi	EA		$ 9,000	$ -	
Reconstruct 6' Drain Manhole or Catch Basi	EA		$ 12,150	$ -	
Watermain relocation	LF	1500	$ 465	$ 697,500	
Gas relocation	LF	900	$ 312	$ 280,800	
CSO Structure	EA	2	$ 100,000	$ 200,000	
8" Sanitary Sewer	LF	1000	$ 126	$ 126,000	
4' Sewer Manhole	EA	4	$ 6,200	$ 24,800	
Curb and Sidewalk	LF	600	$ 67	$ 40,200	
Road Restoration	SY	9480	$ 48	$ 455,040	
Broadway Crossing (Pipe Cost Premium)	LF	200	$ 600	$ 120,000	
Traffic Signal Allowance at Broadway	LS	1	$ 75,000	$ 75,000	
Ledge Allowance	CY		$ 250	$ -	
Unsuitable/Borrow Allowance	CY	4500	$ 35	$ 157,500	
Land Aqusition Allowance	LS	1	$ 250,000	$ 250,000	
Bypass Pumping Mobilization	LS	1	$ 40,000	$ 40,000	
Bypass Pumping	Month	10	$ 50,000	$ 500,000.0	
Rail Crossing (Private)	EA	1	$ 300,000	$ 300,000.0	
Rail Crossing (Signalized)	EA		$ 500,000		
			Subtotal	$ 6,022,140	
Engineering (Design, Permitting & CA)			20%	$ 1,204,428	
Misc/Incidentals			25%	$ 1,505,535	
Contingency			10%	$ 602,214	
			Total	$ 10,581,817	
Cost Escalation	**2022**	**6%**		**$ 11,216,726.02**	

South Portland Facilities Management Plan Update - Alternative 9

Alternative 9C

Item	Unit	Quantity	Cost	Item Total	Note
36" Sewer	LF	2005	$ 360	$ 721,800	
36" Sewer >15' Deep	LF	500	$ 720	$ 360,000	
54" Sewer	LF		$ 720	$ -	
60" Sewer	LF	805	$ 780	$ 627,900	
Jack and Bore 36" Broadway	LF	175	$ 780	$ 136,500	
6' Manholes	EA	13	$ 12,150	$ 157,950	
8' Manholes	EA	5	$ 19,000	$ 95,000	
Special Manholes (Pile Supported)	EA	2	$ 74,750	$ 149,500	
Helical Pile Mobilization/Design/Testing	LS	1	$ 71,500	$ 71,500	
Helical Piles	LF	400	$ 50	$ 20,000	
Jacking Pits	EA	4	$ 111,000	$ 444,000	
12" Stormdrain Reconstruction	LF		$ 158	$ -	
18" Stormdrain Reconstruction	LF		$ 197	$ -	
24" Stormdrain Reconstruction	LF		$ 264	$ -	
30" Stormdrain Reconstruction	LF		$ 300	$ -	
Reconstruct 4' Drain Manhole or Catch Basi	EA		$ 6,200	$ -	
Reconstruct 5' Drain Manhole or Catch Basi	EA		$ 9,000	$ -	
Reconstruct 6' Drain Manhole or Catch Basi	EA		$ 12,150	$ -	
Watermain relocation	LF	465	$ 465	$ 216,225	
Gas relocation	LF	325	$ 312	$ 101,400	
CSO Structure	EA	1	$ 100,000	$ 100,000	
8" Sanitary Sewer	LF		$ 126	$ -	
4' Sewer Manhole	EA		$ 6,200	$ -	
Curb and Sidewalk	LF	350	$ 67	$ 23,450	
Road Restoration	SY	6500	$ 48	$ 312,000	
Broadway Crossing (Pipe Cost Premium)	LF	200	$ 600	$ 120,000	
Traffic Signal Allowance at Broadway	LS	1	$ 75,000	$ 75,000	
Ledge Allowance	CY		$ 250	$ -	
Unsiutable/Borrow Allowance	CY	2942	$ 35	$ 102,978	
Land Aqusition Allowance	LS	1	$ 250,000	$ 250,000	
Bypass Pumping Mobilization	LS	1	$ 40,000	$ 40,000	
Bypass Pumping	Month	7	$ 50,000	$ 350,000.0	
Rail Crossing (Private)	EA	0	$ 300,000	$ -	
Rail Crossing (Signalized)	EA		$ 500,000		
			Subtotal	$ 3,732,225	
Engineering (Design, Permitting & CA)			20%	$ 746,445	
Misc/Incidentals			25%	$ 933,056	
Contingency			10%	$ 373,223	
			Total	$ 6,527,927	
Cost Escalation	**2022**	**6%**		**$ 6,919,602.12**	

South Portland Facilities Management Plan Update - Alternative 9

Alternative 9D

Item	Unit	Quantity	Cost	Item Total	Note
42" Sewer	LF	1950	$ 480	$ 936,000	
42" Sewer >15' Deep	LF	925	$ 960	$ 888,000	
54" Sewer	LF	1515	$ 720	$ 1,090,800	
60" Sewer	LF		$ 780	$ -	
Jack and Bore 36" Broadway	LF	175	$ 780	$ 136,500	
6' Manholes	EA	12	$ 12,150	$ 145,800	
8' Manholes	EA	5	$ 19,000	$ 95,000	
Special Manholes (Pile Supported)	EA	5	$ 74,750	$ 373,750	
Helical Pile Mobilization/Design/Testing	LS	1	$ 71,500	$ 71,500	
Helical Piles	LF	1000	$ 50	$ 50,000	
Jacking Pits	EA	4	$ 111,000	$ 444,000	
12" Stormdrain Reconstruction	LF	500	$ 158	$ 79,000	
18" Stormdrain Reconstruction	LF	250	$ 197	$ 49,250	
24" Stormdrain Reconstruction	LF		$ 264	$ -	
30" Stormdrain Reconstruction	LF		$ 300	$ -	
Reconstruct 4' Drain Manhole or Catch Basi	EA	16	$ 6,200	$ 99,200	
Reconstruct 5' Drain Manhole or Catch Basi	EA		$ 9,000	$ -	
Reconstruct 6' Drain Manhole or Catch Basi	EA		$ 12,150	$ -	
Watermain relocation	LF	1500	$ 465	$ 697,500	
Gas relocation	LF	900	$ 312	$ 280,800	
CSO Structure	EA	2	$ 100,000	$ 200,000	
8" Sanitary Sewer	LF	1000	$ 126	$ 126,000	
4' Sewer Manhole	EA	4	$ 6,200	$ 24,800	
Curb and Sidewalk	LF	600	$ 67	$ 40,200	
Road Restoration	SY	9480	$ 48	$ 455,040	
Broadway Crossing (Pipe Cost Premium)	LF	200	$ 600	$ 120,000	
Traffic Signal Allowance at Broadway	LS	1	$ 75,000	$ 75,000	
Ledge Allowance	CY		$ 250	$ -	
Unsuitable/Borrow Allowance	CY	4900	$ 35	$ 171,500	
Land Aqusition Allowance	LS	1	$ 250,000	$ 250,000	
Bypass Pumping Mobilization	LS	1	$ 40,000	$ 40,000	
Bypass Pumping	Month	10	$ 50,000	$ 500,000.0	
Rail Crossing (Private)	EA	1	$ 300,000	$ 300,000.0	
Rail Crossing (Signalized)	EA		$ 500,000		
			Subtotal	$ 6,478,140	
Engineering (Design, Permitting & CA)			20%	$ 1,295,628	
Misc/Incidentals			25%	$ 1,619,535	
Contingency			10%	$ 647,814	
			Total	$ 11,302,617	
Cost Escalation	**2022**	**6%**		**$ 11,980,774.02**	

South Portland Facilities Management Plan Update - Alternative 13

Alternative 13 Area 1 Woodland and Cottage/Shore Road
(Stand Alone Project)

Item	Unit	Quantity	Cost	Item Total	Note
12" Storm Drain	LF	300	$ 158	$ 47,400	
15" Storm Drain	LF	235	$ 182	$ 42,770	
18" Storm Drain	LF	15	$ 197	$ 2,955	
30" Storm Drain	LF	376	$ 300	$ 112,800	
4' Catch Basins	EA	6	$ 6,100	$ 36,600	
4' Drain Manholes	EA	4	$ 6,200	$ 24,800	
5' Drain Manholes	EA	1	$ 9,000	$ 9,000	
6' Drain Manholes	EA	4	$ 12,150	$ 48,600	
Watermain relocation	LF	100	$ 465	$ 46,500	
8" Sanitary Sewer	LF	100	$ 126	$ 12,600	
4' Sewer Manhole	EA	4	$ 6,200	$ 24,800	
Curb and Sidewalk	LF	600	$ 67	$ 40,200	
Road Restoration	SY	1940	$ 48	$ 93,120	
Ledge Allowance	CY	343	$ 250	$ 85,741	
			Subtotal	$ 627,886	
Engineering (Design, Permitting & CA)			20%	$ 125,577	
Misc/Incidentals			25%	$ 156,971	
Contingency			10%	$ 62,789	
			Total	$ 973,223	
Cost Escalation	**2022**	**6%**		**$ 1,031,616.27**	

South Portland Facilities Management Plan Update - Alternative 13

Alternative 13 Area 1 Woodland and Cottage/Shore Road (within PACTS Project)

Item	Unit	Quantity	Cost		Item Total		Note
12" Storm Drain	LF	300	$	158	$	47,400	
15" Storm Drain	LF	235	$	182	$	42,770	
18" Storm Drain	LF	15	$	197	$	2,955	
30" Storm Drain	LF	376	$	300	$	112,800	
4' Catch Basins	EA	6	$	6,100	$	36,600	
4' Drain Manholes	EA	4	$	6,200	$	24,800	
5' Drain Manholes	EA	1	$	9,000	$	9,000	
6' Drain Manholes	EA	4	$	12,150	$	48,600	
Watermain relocation	LF		$	465	$	-	
8" Sanitary Sewer	LF	100	$	126	$	12,600	
4' Sewer Manhole	EA	4	$	6,200	$	24,800	
Curb and Sidewalk	LF		$	67	$	-	
Road Restoration	SY		$	48	$	-	
Ledge Allowance	CY	342.96296	$	250	$	85,741	
			Subtotal		$	448,066	
Engineering (Design, Permitting & CA)				15%	$	67,210	
Misc/Incidentals				25%	$	112,016	
Contingency				10%	$	44,807	
			Total		$	672,099	
Cost Escalation	**2022**	**6%**			**$**	**712,424.53**	

South Portland Facilities Management Plan Update - Alternative 13

Alternative 13 Area 3 Cottage Road- Sawyer Road to Pillsbury
(Stand Alone Project)

Item	Unit	Quantity	Cost		Item Total	
12" Storm Drain	LF	850	$	158	$	134,300
15" Storm Drain	LF		$	182	$	-
18" Storm Drain	LF	230	$	197	$	45,310
24" Storm Drain	LF	500	$	264	$	132,000
4' Catch Basins	EA	12	$	6,100	$	73,200
4' Drain Manholes	EA	9	$	6,200	$	55,800
5' Drain Manholes	EA	4	$	9,000	$	36,000
6' Drain Manholes	EA		$	12,150	$	-
Watermain relocation	LF	490	$	465	$	227,850
8" Sanitary Sewer	LF	460	$	126	$	57,960
4' Sewer Manhole	EA	4	$	6,200	$	24,800
Curb and Sidewalk	LF	1400	$	67	$	93,800
Road Restoration	SY	5200	$	48	$	249,600
Ledge Allowance	CY	585	$	250	$	146,296
			Subtotal		$	1,276,916
Engineering (Design, Permitting & CA)				20%	$	255,383
Misc/Incidentals				25%	$	319,229
Contingency				10%	$	127,692
			Total		$	1,979,220
Cost Escalation	**2022**	**6%**			**$**	**2,097,973**

South Portland Facilities Management Plan Update - Alternative 13

Alternative 13 Area 3 Cottage Road Sawyer- Road to Pillsbury
(within PACTS Project)

Item	Unit	Quantity	Cost	Item Total
12" Storm Drain	LF	850	$ 158	$ 134,300
15" Storm Drain	LF	0	$ 182	$ -
18" Storm Drain	LF	230	$ 197	$ 45,310
24" Storm Drain	LF	500	$ 264	$ 132,000
4' Catch Basins	EA	12	$ 6,100	$ 73,200
4' Drain Manholes	EA	9	$ 6,200	$ 55,800
5' Drain Manholes	EA	4	$ 9,000	$ 36,000
6' Drain Manholes	EA	0	$ 12,150	$ -
Watermain relocation	LF		$ 465	$ -
8" Sanitary Sewer	LF	460	$ 126	$ 57,960
4' Sewer Manhole	EA	4	$ 6,200	$ 24,800
Curb and Sidewalk	LF		$ 67	$ -
Road Restoration	SY	1400	$ 48	$ 67,200
Ledge Allowance	CY	585	$ 250	$ 146,296
			Subtotal	$ 772,866
Engineering (Design, Permitting & CA)			15%	$ 115,930
Misc/Incidentals			25%	$ 193,217
Contingency			10%	$ 77,287
			Total	$ 1,159,299
Cost Escalation	**2022**	**6%**		**$ 1,228,857**

South Portland Facilities Management Plan Update - Alternative 15

Alternative 15 Renewal Area- CSO 018 Full Sewershed

Item	Unit	Quantity	Cost	Item Total	Note
Lining/Rehabilitation 6" and 8"	LF	13980	$ 65	$ 908,700	Current South Portland rates
Lining/Rehabilitation 10"	LF	14715	$ 72	$ 1,059,480	
Lining/Rehabilitation 12"	LF	9036	$ 80	$ 722,880	
Lining/Rehabilitation 15"	LF	3778	$ 95	$ 358,910	
Lining/Rehabilitation 18"	LF	2841	$ 105	$ 298,305	
Lining/Rehabilitation 20"	LF	2161	$ 125	$ 270,125	
Lining/Rehabilitation 24"	LF	1844	$ 135	$ 248,940	
Lining/Rehabilitation 30"	LF	274	$ 150	$ 41,100	
Line Manholes	EA	68	$ 276	$ 18,768	
Replace 8" Sewer	LF	10176	$ 126	$ 1,282,176	
Replace 10" Sewer	LF	3678	$ 138	$ 507,564	
Replace 12" Sewer	LF	2138	$ 135	$ 288,630	
Replace 15" Sewer	LF	1130	$ 168	$ 189,840	
Replace 18" Sewer	LF	422	$ 200	$ 84,400	
Replace 24" Sewer	LF	155	$ 300	$ 46,500	
Replace Manholes	EA	133	$ 6,200	$ 824,600	
Bypass Pumping Mobilization	LS	1	$ 40,000	$ 40,000	
Bypass Pumping	Month	18	$ 50,000	$ 900,000	
Road Restoration (Trench Repair)	LF	17699	$ 43	$ 761,057	
			Subtotal	$ 8,851,975	
CCTV Inspection/Assessments	LF	59208	$ 5	$ 296,040	Estimated
Engineering (Design, Permitting & CA)	LS		20%	$ 1,770,395	
Misc/Incidentals	LS		25%	$ 2,212,994	
Contingency			10%	$ 885,198	
			Total	$ 13,131,404	
Cost Escalation	**2022**	**6%**		**$ 13,919,288**	Ongoing Annual Program

South Portland Facilities Management Plan Update - Alternative 14

Alternative 15 Renewal Area CSO 018 Phase 1 (Priority Area)

Item	Unit	Quantity	Cost	Item Total	Note
		25%	Priority Area		
Lining/Rehabilitation 6" and 8"	LF	3495	$ 65	$ 227,175	Current South Portland rates
Lining/Rehabilitation 10"	LF	3679	$ 72	$ 264,870	
Lining/Rehabilitation 12"	LF	2259	$ 80	$ 180,720	
Lining/Rehabilitation 15"	LF	945	$ 95	$ 89,728	
Lining/Rehabilitation 18"	LF	710	$ 105	$ 74,576	
Lining/Rehabilitation 20"	LF	540	$ 125	$ 67,531	
Lining/Rehabilitation 24"	LF	461	$ 135	$ 62,235	
Lining/Rehabilitation 30"	LF	69	$ 150	$ 10,275	
Line Manholes	EA	17	$ 276	$ 4,692	
Replace 8" Sewer	LF	2544	$ 126	$ 320,544	
Replace 10" Sewer	LF	920	$ 138	$ 126,891	
Replace 12" Sewer	LF	535	$ 135	$ 72,158	
Replace 15" Sewer	LF	283	$ 168	$ 47,460	
Replace 18" Sewer	LF	106	$ 200	$ 21,100	
Replace 24" Sewer	LF	39	$ 300	$ 11,625	
Replace Manholes	EA	33	$ 6,200	$ 206,150	
Bypass Pumping Mobilization	LS	1	$ 40,000	$ 40,000	
Bypass Pumping	Month	5	$ 50,000	$ 225,000	
Road Restoration (Trench Repair)	LF	4425	$ 43	$ 190,264	
			Subtotal	$ 2,242,994	
CCTV Inspection/Assessments	LF	14802	$ 5	$ 74,010	Estimated
Engineering (Design, Permitting & CA)	LS		20%	$ 448,599	
Misc/Incidentals	LS		25%	$ 560,748	
Contingency			10%	$ 224,299	
			Total	$ 3,326,351	
Cost Escalation	**2022**	**6%**		**$ 3,525,931.99**	Ongoing Annual Program

South Portland Facilities Management Plan Update - Alternative 16

Alternative 16A

Item	Unit	Quantity	Cost		Item Total		Note
12" Storm Drain	LF	650	$	158	$	102,700	
48" Storm Drain	LF	110	$	570	$	62,700	
4' Catch Basins	EA	21	$	6,100	$	128,100	
8' Drain Manholes	EA	2	$	19,000	$	38,000	
Watermain relocation	LF	2400	$	465	$	1,116,000	
Gas relocation	LF	2400	$	312	$	748,800	
42" Sanitary Sewer	LF	670	$	420	$	281,400	
42" Sanitary Sewer>15' Deep	LF	3500	$	840	$	2,940,000	
42" Sanitary Sewer (across Residential Lots)	LF	730	$	840	$	613,200	
8" Sanitary Sewer	LF	610	$	126	$	76,860	
6' Sewer Manhole	EA	24	$	12,150	$	291,600	
Special Manholes	EA	4	$	74,750	$	299,000	
Helical Piles	LF	800	$	50	$	40,000	
Helical Pile Mobilization/Design/Testing	LS	1	$	71,500	$	71,500	
Curb and Sidewalk	LF	400	$	67	$	26,800	
Road Restoration	SY	17400	$	48	$	835,200	
Broadway Crossing (Pipe Cost Premium)	LF	200	$	600	$	120,000	
Traffic Signal Allowance at Broadway	LS	1	$	75,000	$	75,000	
Ledge Allowance	CY	347	$	250	$	86,852	
Rail Crossing (Private)	EA	2	$	300,000	$	600,000	
Bypass Pumping Mobilization	LS	1	$	40,000	$	40,000	
Bypass Pumping	Month	10	$	50,000	$	500,000.0	
			Subtotal		$	9,093,712	
Engineering (Design, Permitting & CA)				20%	$	1,818,742	
Misc/Incidentals				25%	$	2,273,428	
Contingency				10%	$	909,371	
			Total		$	14,095,253	
Cost Escalation	**2022**	**6%**			**$**	**14,940,969***	

*COST TO BE COMBINED WITH ALTERNATE 9D TO DETERMINE TOTAL COST TO PROVIDE 10-YEAR CONTROL AT CSO #005 AND #006

APPENDIX E: MAINE DEP RESPONSE TO DRAFT PLAN UPDATE

STATE OF MAINE
DEPARTMENT OF ENVIRONMENTAL PROTECTION

JANET T. MILLS
GOVERNOR

MELANIE LOYZIM
COMMISSIONER

November 15, 2021

Megan McDevitt, PE
Senior Project Manager
Woodard & Curran
41 Hutchins Dr
Portland, ME 04102

RE: South Portland's 2021 CSO Master Plan Update (MPU)

Dear Megan,

Thank you for submitting the 2021 CSO MPU on behalf of the City of South Portland. As we discussed in our recent virtual meeting, we have completed our review of the MPU and would like several questions answered before we make a final decision on whether to approve the MPU as submitted, or request modifications to the plan. But first, we'll offer some general comments on the MPU and the direction the City wants to go in with respect to CSO abatement.

General Comments on MPU

<u>Comments Pertaining to the Entire Sewer System</u>

- We were pleased to see that recommendations contained in the 2021 CSO MPU are supported by an update of the hydraulic model of the sewer system. When committing millions of dollars to CSO abatement and infrastructure renewal over a ten-year period, it's essential to have a fully calibrated model to confirm the best approach.
- Over the past 28 years, South Portland has done a very credible job with CSO abatement and has made significant progress in meeting their objective of pushing flows to the WWTF and reducing upstream CSO discharge. We were pleased to see that the alternative analysis contained in the MPU resulted in recommendations to continue this approach for two of the four remaining active CSO's (006 and 024).
- The DEP is not yet in total agreement with recommendations for the other two CSO's (005 and 018). To convince us that the appropriate abatement techniques are being proposed would require some additional information which we outline in our section on Outstanding Questions.
- The 2021 CSO MPU did not include any Financial Capability Analysis (FCA) on the impact of the proposed plan on sewer rates. An FCA helps to determine whether the proposed plan strikes the right balance between pursuing abatement goals and not overburdening the City's sewer customers, particularly the lowest two quintiles of household earners.
- Elimination of CSO discharge to sensitive receiving waters should be mentioned in Section 4 of the MPU as a primary DEP directive. We are working with a handful of CSO communities around

the State to eliminate the last remaining CSO's which still discharge to small, sensitive receiving waters. Despite their current condition, South Portland has two sensitive receiving waters in Barberry Creek and Calvery Ponds which should be protected from both CSO discharge and stormwater discharge that is considered harmful due to hydrocarbons. The rehabilitation of these two water bodies needs to start by eliminating discharge to them.

- We support the City's efforts to combine renewal of infrastructure that has reached the end of its service life with CSO abatement, where it makes sense and where you can achieve dual benefits.

<u>Comments on the Proposed Abatement Plan - Western Portion of Collection System</u>

- According, to the MPU, groundwater infiltration is the biggest source of excess water entering the western portion of the collection system. As such, relining and replacement of leaky pipes can be added to the list of viable abatement options joining the option to push flow downstream to the WWTF.
- Past CSO MPU's submitted by the City have focused on pushing flow from the west towards the wastewater treatment facility (WWTF). We've supported this effort as it reduces CSO discharge to sensitive receiving waters, such as Barberry Creek (CSO 006) and Calvery Pond (CSO 005) and pushes CSO discharge towards the less sensitive receiving waters of Portland Harbor (CSO 024).
- The 2021 CSO MPU recommends continuing this approach for CSO 006 by removing down steam flow restrictions and promoting flow from CSO 006 to the Pearl Street Pump Station (PSPS). Depending on the size of the storm and the volume of flow to PSPS, CSO 024 may be activated in the process.
- It is our understanding that PSPS will be undergoing an upgrade in the next few years, so there is an opportunity for South Portland to size the upgrade to push more flow to the WWTF and reduce discharge from CSO's 005, 006, and 024. It continues to make sense to push flow downstream from PSPS since the City has invested in a CSO related bypass of secondary treatment at the WWTF.
- Use of the CSO related bypass has averaged around 1% of overall flows treated over the past five years which we do not consider excessive. In most cases, we would prefer the use of the bypass where flow receives primary treatment and disinfection, as opposed to the flow exiting at an upstream CSO location and receiving zero treatment.
- The proposed plan does not recommend pushing flow downstream from the western most CSO 005 to CSO 006. Instead it recommends some relining and sewer replacement projects to reduce excess water from entering the collection system and reaching CSO 005. Keeping the excess water out of the collection system via relining or replacement is a viable strategy for these areas, although perhaps not the best strategy for CSO 005 which would be continuing to push flow downstream.
- Fortunately, the plan does not recommend large scale sewer separation for either CSO 005 or 006. We agree that separation is not the best abatement tool for these areas as the stormwater would be "hot" or laden with hydrocarbons from heavy traffic at intersections, and not suitable for release to a small sensitive receiving water.

- The CSO regulators for both CSO 005 and CSO 006 have what we refer to as "engineered flow restrictions", meaning the upstream flow capacity outpaces the downstream flow capacity, creating a flow restriction and built in CSO discharge to the closest water body. This seems to have been a common approach throughout Maine to limit downstream flows. Unfortunately, until the flow restrictions are removed, as you're proposing to do for CSO 006, CSO activity will continue.
- The flow restriction at CSO 006 is created by a 40" diameter upstream pipe being reduced to 34" diameter downstream pipe. This equates to an upstream flow capacity of 18.7 MGD and a downstream flow capacity of 13.5MGD.
- The flow restriction at the CSO 005 regulator is even more of a bottleneck. The regulator has a 36" pipe and a 24" pipe entering from upstream and a 36" pipe which quickly reduces to 32" pipe exiting downstream.
- South Portland's original level of control (LOC) established in their 1993 CSO Master Plan was 98% based on 1989 flows. In other words, 2% of the overall flow would not receive any treatment. In subsequent MPU's, after the implementation of the CSO related bypass of secondary treatment, the LOC was upgraded to controlling a 2-year, 24-hour storm at each of the four remaining CSO locations.
- The City has not achieved this level of control yet but proposes to by the end of the ten-year MPU. While controlling a 2-year storm after ten years may be appropriate for CSO's which discharge to the more forgiving Portland Harbor, we don't feel this goal is aggressive enough for the two remaining CSO's which discharge to sensitive receiving waters. For CSO 005 and 006, the DEP's preferred endpoint is to see all discharge eliminated by the end of the ten-year period, i.e., full closure of the two CSO locations.
- As mentioned in our meeting, the DEP generally allows the CSO closest to the WWTF to be converted to an emergency overflow at the end of the abatement effort to protect the WWTF from flooding. CSO 024 would play this role in South Portland for flows from the west. Keep in mind any CSO transitioned to an Emergency Overflow will have to be electronically monitored 24/7 with any discharge treated as an illicit SSO and reported accordingly. For that reason, discharge at an emergency overflow needs to be very infrequent or else the City would be opening themselves up to enforcement actions for excessive SSO activity.
- Currently, the CSO 024 regulator has a 36" pipe coming into the structure and a 30" pipe exiting the structure after making a 90 degree turn in flow direction. Again, this presents not only a flow restriction via the reduced pipe size but also a very challenging geometry for the flow passing through the regulator, a situation which promotes CSO discharge. Whenever the incoming flow hits up against a weir and must make a 90 degree turn there will be backup and surcharging. We would like to see improvements to the geometry of the CSO 024 regulator as part of the conveyance improvements between CSO 006 and PSPS.

Comments on the Proposed Abatement Plan - Eastern Portion of Collection System

- According to the MPU, surface water inflow is the largest contributor to excess water in the eastern portion of the collection system. As a result, separation of the remaining 41 catch basins is viable abatement strategy. Groundwater infiltration, on the other hand, is not as big an issue as on the western side, so relining and replacement options are not as impactful.

- We are less convinced that the effort to remove infiltration from this area of the collection system makes economic sense from a CSO abatement aspect. If the City is obtaining dual benefits by replacing infrastructure at the end of its service life, then the cost/benefit ratio shifts somewhat. Take solely as a CSO reduction effort, it doesn't make sense, with the money being better used elsewhere.
- The CSO MPU states that CSO 018 discharges to the Fore River, when it actually discharges to Portland Harbor as indicated in South Portland's MePDES permit and waste discharge license. Please make this change to the MPU to be consistent with the permit.
- In the past, the Front Street Pump Station had to be throttled at 85% speed because of downstream capacity limitations. If recent upgrades to the downstream interceptor have removed the flow restrictions, then pushing flow to the WWTF would make a good deal of sense. That option, combined with the separation of 41 catch basins, may generate the desired LOC at CSO 018.
- We understand the City is interested in establishing an emergency overflow for the eastern portion of the collection system as well. To make this happen, the City would have to make the case to the DEP as to what the emergency overflow is needed for. What infrastructure would it be protecting from flooding? What is the history and likelihood of flooding in the eastern portion of the collection system? What abatement options are available to preclude the need for an emergency overflow on this side of the collection system?

Outstanding Questions to Be Answered

<u>System Wide Questions</u>

1. From a financial capability standpoint, what level of burden will the proposed abatement plan place on sewer customers over the ten-year timeframe? What extra level of burden would be placed on sewer customers by eliminating CSO discharge at CSO 005 and 006:
    a. For all storm sizes?
    b. For a 5-Year, 24 - hour storm?
    c. For a 10-Year, 24-hour storm?

<u>Questions - Western Portion of Collection System</u>

1. Using your fully calibrated model, please identify what changes to your current recommendation of upgrading conveyance and storage between CSO 006 and PSPS would be needed to:
    a. Fully eliminate discharge to Barberry Creek from CSO 006 for all size storms?
    b. Eliminate discharge to Barberry Creek for a 10-year, 24-hour storm?
    c. Eliminate discharge to Barberry Creek for a 5-year, 24-hour storm?
    d. What would be the incremental cost for each of these options?
2. Using the model, please identify what conveyance improvements would be needed between CSO 005 and CSO 006 to push flow downstream to:
    a. Fully eliminate discharge to Calvery Ponds from CSO 005 for all size storms?

   b. Eliminate discharge to Calvery Ponds for a 10-year, 24-hour storm?
   c. Eliminate discharge to Calvery Ponds for a 5-year, 24-hour storm?
   d. What would be the cost for each of these options?
3. What is the modeled impact of raising the weir at CSO 005 by 12”:
   a. On CSO 005 discharge for a 5-year, 24-hour storm?
   b. On CSO 005 discharge for a 10-year, 24-hour storm?
4. It’s our understanding that CSO 024 will remain in its current location when the PSPS upgrade is implemented. What changes in the geometry of the CSO 024 regulator can be made to improve flow through the regulator and on to PSPS, while reducing CSO activity? Are there opportunities to raise the weir elevation at this regulator?
5. What impact would it have on the size and cost of the PSPS upgrade, if the City pushed enough flow to PSPS to eliminate CSO 005 and 006:
   a. For all storm sizes?
   b. For a 5-year, 24-hour storm?
   c. For a 10-year, 24-hour storm?

<u>Questions - Eastern Portion of Collection System</u>

1. Based on the model, what pumping rate would the Front Street Pump Station have to operate at to:
   a. Eliminate discharge at CSO 018 for all sized storms, solely by pushing flow to the WWTF?
   b. Eliminate discharge at CSO 018 for a 5-year, 24-hour storm solely by pushing flow to the WWTF?
   c. Eliminate discharge at CSO 018 for a 10-year, 24-hour storm solely by pushing flow to the WWTF?
   d. Eliminate discharge at CSO 018 for all sized storms by separating the 41 catch basins and pushing the remaining excess flow to the WWTF?
   e. Eliminate discharge at CSO 018 for a 5-year, 24-hour storm by separating the 41 catch basins and pushing the remaining excess flow to the WWTF?
   f. Eliminate discharge at CSO 018 for a 10-year, 24-hour storm by separating the 41 catch basins and pushing the remaining excess flow to the WWTF?

2. Is the current capacity of downstream sewer infrastructure sufficient to accept the flows generated under options a through f, considering the recent upgrade of the Greenbelt interceptor?
3. If not, can the downstream capacity be upgraded to accept the flows generated under options a through f? What would be the cost to upgrade the downstream capacity to be able to convey the flows from each of these six options.
4. There doesn’t appear to be a regulator sketch for CSO 018 included in the appendix. Is the regulator just an overflow weir in the pump station wetwell?

Closing

The City of South Portland, and their consultant, have done a good job laying out the various CSO abatement alternatives available to the City in each area of the collection system. To allow us to finish our assessment of the MPU, we've posed a series of questions which the recently calibrated hydraulic model can be used to answer. The answers to those questions will give us a better idea on whether the proposed abatement plan is aggressive enough. In other words, will the plan generate benefits commensurate with the urgency faced by the City with respect to CSO abatement/elimination?

We're available to discuss any of our comments or questions in more detail if that would be helpful. We look forward to your response and moving ahead with the next phase of CSO abatement in South Portland.

Sincerely,

Mike Riley

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CC:

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Jonathan Rice, P.E. Maine DEP Augusta
Stuart Rose, Maine DEP SMRO

APPENDIX F: FINANCIAL CAPABILITY ASSESSMENT WORKSHEETS

COST PER HOUSEHOLD
Worksheet 1

		Line Number
Current WWT Costs		
• Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ 5,267,011.91	100
• Annual Debt Service (Principal and Interest)	$ 95,193.31	101
Subtotal (Line 100 + 101)	$ 5,362,205.22	102
Projected WWT and CSO Costs (Current Dollars)		
• Estimated Annual Operations and Maintenance Expenses (Excluding Depreciation)	$ -	103
• Annual Debt Service CSO Abatement Projects* (Principal and Interest)	$ 1,552,224.00	104a
• Annual Debt Service Water Resource CIP (FY23-29)* (Principal and Interest)	$ 2,287,202.51	104b
Subtotal (Line 103 + 104a + 104b)	$ 3,839,426.51	105
Total Current and Projected WWT and CSO Costs (Line 102 + Line 105)	$ 9,201,631.73	106
Residential Share of Total WWT and CSO Costs	$ 6,625,174.84	107
Total Number of Households in Service Areas	7,907	108
Cost Per Household (Line 107 ÷ Line 108)	$ 837.89	109

*Assumes a 20-year loan at 4% through Maine DEP SRF programs

RESIDENTAL INDICATOR
Worksheet 2

		Line Number
Median Household Income (MHI)		
• Census Year MHI	$ 67,198.00	201
• MHI Adjustment Factor	1.097	202
• Adjusted MHI (Line 201 x Line 2022)	$ 73,688.02	203
Annual WWT and CSO Control Cost Per Household (CPH) (Line 109)	$ 837.89	204
Residential Indicator:		
Annual Wastewater and CSO Control Costs per Household as a percent of Adjusted Median Household Income (CPH as % MHI) (Line 204 ÷ Line 203 x100)	1.14 %	205
	Financial Impact	MID-RANGE

BOND RATING
Worksheet 3

		Line Number
• Most Recent General Obligation Bond Rating		
Date:	March 15, 2022	
Rating Agency	Moody's	
Rating	Aaa	301
• Most Recent General Obligation Bond Rating		
Date:	March 14, 2022	
Rating Agency	Standard & Poor's	
Rating	AAA	302
Summary Bond Rating	Aaa	303
	Benchmark	STRONG

OVERALL NET DEBT AS A PRECENT OF FULL MARKET PROPERTY VALUE
Worksheet 4

		Line Number
• Direct Net Debt (GO Bonds Excluding Double-Barreled Bonds)	$ 45,130,000.00	401
Source	City of South Portland, Maine Annual Comprehensive Financial Report For Fiscal Year Ended June 30, 2021	
• Direct Net Overlapping Entities (Proportionate Share of Multijurisdictional Debt)	$ 10,487,467.80	402
Source	City of South Portland, Maine Annual Comprehensive Financial Report For Fiscal Year Ended June 30, 2021	
• Overall Net Debt (Line 401 + 402)	$ 55,617,467.80	403
• Market Value of Property	$ 3,622,586,200.00	404
Source	City of South Portland, Maine Annual Comprehensive Financial Report For Fiscal Year Ended June 30, 2021	
• Overall Net Debt as a Precent of Full Market Property Value (Line 403 divided by Line 404 x 100)	$ 1.54 %	405
	Benchmark	STRONG

UNEMPLOYMENT RATE
Worksheet 5

			Line Number
• Unemployment Rate - Permittee	4.10	%	501
Source	Maine Center for Workforce Research and Information (2021 Average)		
• Unemployment Rate - County (use if permittee's rate is unavailable)			502
Source			
Benchmark			
• Average National Unemployment Rate	5.36	%	503
Source	Maine Center for Workforce Research and Information (2021 Average)		
Comparison of Permittee with Benchmark	-1.26	%	STRONG

MEDIAN HOUSEHOLD INCOME
Worksheet 6

		Line Number
• Median Household Income Permittee (Line 203)	$ 73,688.02	601
Source	From Census 2016-2020 ACS 5-year estimates	
Benchmark		
• Census Year National MHI	$ 64,994.00	602
MHI Adjustment Factor (Line 202)	1.097	603
• Average National MHI (Line 602 x Line 603)	$ 71,271.16	604
Source	US Census Bureau	
Comparison of Permittee with Benchmark	1.03 %	MID-RANGE

PROPERTY TAX REVENUES AS A PERCENT OF FULL MARKET PROPERTY VALUE
Worksheet 7

		Line Number
• Full Market Value of Real Property (Line 404)	$ 3,622,586,200.00	701
• Property Tax Revenues	$ 70,617,202.00	702
Source	City of South Portland, Maine Annual Comprehensive Financial Report For Fiscal Year Ended June 30, 2021	
• Property Tax Revenues as a Percent of Full Market Property Values (Line 702 ÷ Line 701 x100)	1.95 %	703
	Benchmark	STRONG

PROPERTY TAX REVENUE COLLECTION RATE
Worksheet 8

		Line Number
• Full Market Value of Real Property (Line 702)	$ 70,617,202.00	801
• Property Tax Levied	$ 71,546,077.00	802
Source	City of South Portland, Maine Annual Comprehensive Financial Report For Fiscal Year Ended June 30, 2021	
• Property Tax Revenue Collection Rate (Line 801 ÷ Line 801 x100)	98.70 %	803
	Benchmark	STRONG

SUMMARY OF PERMITTEE FINANCIAL CAPABILITY INDICATORS
Worksheet 9

Indicator	Column A Actual Value	Column B Score	Line Number
• Bond Rating (Line 303)	Aaa	3	901
• Overall Net Debt as a Percent of Full Market Property Value (Line 405)	1.54%	3	902
• Unemployment Rate (Line 501)	-1.26%	3	903
• Median Household Income (Line 601)	1.03%	2	904
• Property Tax Revenue as a Percent of Full Market Property Value (Line 703)	1.95%	3	905
• Property Tax Revenue Collection Rate (Line 803)	98.70%	3	906
Permittee Indicator Score (Sum of Column B ÷ Number of Entries)		2.83	907

FINANCIAL CAPABILITY MATRIX SCORE
Worksheet 10

		Line Number
• Residential Indicator Score (Line 205)	1.14%	1001
• Permittee Financial Capability Indicators Score (Line 907)	2.83	1002
• Financial Capability Matrix Category	Low Burden	1003

FINANCIAL CAPABILITY MATRIX
Table 3

Permittee Financial Capability Indicators Score (Socioeconomic, Debt and Financial Indicators)	**Residential Indicator** (Cost Per Household as a % of MHI)		
	Low (Below 1.0 %)	Mid-Range (Between 1.0 and 2.0%)	High (Above 2.0 %)
Weak (Below 1.5)	Medium Burden	High Burden	High Burden
Mid-Range (Between 1.5 and 2.5)	Low Burden	Medium Burden	High Burden
Strong (Above 2.5)	Low Burden	Low Burden	Medium Burden

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