DRAFT REPORT

City of New Haven Combined Sewer Overflow Long-Term Control Plan Update

Prepared for

Greater New Haven Water Pollution Control Authority

December 2016

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Acronyms and Abbreviations

ACH	air changes per hour
AFD	adjustable frequency drive
AOR	allowable operating range
Authority	Greater New Haven Water Pollution Control Authority
BEP	best efficiency point
BOD	biochemical oxygen demand
BRB	biological reactor basin
CEPT	chemically enhanced primary treatment
CFD	computational fluid dynamics
cfm	cubic feet per minute
CIP	Capital Improvements Plan
City	the City of New Haven
CSO	combined sewer overflow
CT DEEP	Connecticut Department of Energy and Environmental Protection
CWF	Clean Water Fund
dBA	decibel
DBP	di-butyl phthalate
DCIA	directly connected impervious area
DWF	dry weather flow
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FOG	fat, oil, and grease
ft^2	square foot (feet)
GI	green infrastructure
GIS	geographic information system
GNHWPCA	Greater New Haven Water Pollution Control Authority
gpd	gallon(s) per day
gpm	gallon(s) per minute
H_2S	hydrogen sulfide
HI	Hydraulic Institute
hp	horsepower
HVAC	heating, ventilation, and air conditioning
I&C	instrumentation and control
IFAS	integrated fixed-film activated sludge
ITCP	Intermediate-Term CSO Control Plan
kV	kilovolt
kW	kilowatt
LTCP	Long-Term Control Plan
MG	million gallon(s)
mg/L	milligrams per liter
mgd	million gallon(s) per day
MLE	Modified Ludzack-Ettinger
MLR	mixed liquor recirculation

MLSS	mixed liquor suspended solids
NDMA	N-nitrosodimethylamine
NEIWPCC	New England Interstate Water Pollution Control Commission
NFPA	National Fire Protection Association
NH_3	ammonia
NH_4	ammonium
NMCs	Nine Minimum Controls
NPDES	National Pollutant Discharge Elimination System
NRCC	Northeastern Regional Climate Center
NRCY	nitrified mixed liquor recycle
OPCC	Opinion of Probable Cost
ORP	oxidation reduction potential
P&ID	process and instrumentation diagram
PLC	programmable logic controller
POR	preferred operating range
RAS	return activated sludge
SCADA	supervisory control and data acquisition
scfm	standard cubic feet per minute
SRT	solids retention time
STCP	Short-Term CSO Control Plan
TDH	total dynamic head
TKN	total Kjeldahl nitrogen
TN	total nitrogen
TSS	total suspended solids
TWAS	thickened waste activated sludge
UI	United Illuminating
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet
VFD	variable-frequency drive
WAS	waste activated sludge
WPAF	Water Pollution Abatement Facility
WPCA	Water Pollution Control Authority
WWF	wet weather flow

Executive Summary

Pursuant to Consent Order WC5509, the Greater New Haven Water Pollution Control Authority (GNHWPCA, the Authority) has agreed to update the City of New Haven's *Combined Sewer Overflow Long-Term Control Plan* (CSO LTCP) every 5 years. The last update to the LTCP was approved by Connecticut Department of Energy and Environmental Protection (CT DEEP, DEEP) in 2011. This report documents the 2016 CSO LTCP update. Under this update, three phases of controls are recommended to meet the goals of the Consent Order. These phases include the Short-Term Control Plan (STCP) to be completed by 2018, the Intermediate-Term Control Plan (ITCP) and the Long-Term Control Plan.

Introduction

The goal of the CSO LTCP is to provide for measures necessary to remove or control CSO discharges from all CSO outfalls resulting from wet weather events up to and including the 2-year, 6-hour design storm for the service area by 2040. Since the City began work on the first CSO LTCP in 1997, CSO volumes have effectively been reduced through sewer separation projects and construction of the Truman CSO Storage Tank. Recently, GNHWPCA has begun to focus on lower cost regulator improvement projects that utilize data from their CSO Flow Monitoring Program, which began in 2012, and their Hydraulic Model, which was updated in 2015. These efforts have yielded tangible results. Between 1997 and 2015, CSO volumes have been effectively reduced by 46% during the design storm from 26 MG to 14 MG and 66% during the typical year from 126 MG over 51 events to 43 MG over 30 events.

The first CSO LTCP was approved by DEEP in 2003. The first update to the CSO LTCP was approved by DEEP in 2011. This current CSO LTCP update is focused on ITCP projects. These improvements include the Yale Campus/Trumbull St. Phase 2A Sewer Separation and Upgrades to the East Street, Union and Boulevard Pump Stations which will increase capacity, improve reliability and provide flood resilience.

Plan Development

The recommended plan was developed based on alternatives analysis and evaluation presented in this report. The analysis relied on CSO characteristics generated by the 2015 updated Hydraulic Model which incorporated CSO reduction projects completed through the end of 2040. The components of the plan are listed by implementation phase to follow the timeline agreed to in the Consent Order.

The controls included in the STCP are listed below and shown on Figure ES-1.

- **Regulators 012 and 020 Relief Sewers (CWF 2016-02) –** The design and construction of individual relief sewer segments and regulator improvements to reduce CSO frequency, duration and volume at CSO outfalls 012 and 020.
- **West River CSO Improvements (CWF 2016-03) –** The design and construction of improvements and modifications to Regulators 003, 004 and 006 along the Boulevard Trunk Sewer to reduce CSO discharges to the West River.
- **Regulator 034 Regulator Improvements (CWF 2016-05) –** The design and construction of regulator improvements to reduce CSO frequency, duration and volume at CSO regulator 034 and CSO outfall 025.
- **Green Infrastructure Improvements (CWF 2016-07) –** The design and construction of approximately 75 bioswales along City streets within combined sewer areas in the West River watershed to reduce the CSO frequency, duration and volume to the West River.

- **Cleaning of Front and River Street Sewers –** The inspection and cleaning of sewers along Front and River Street to the James Street Siphon to increase conveyance and capacity upstream of Regulators 015 and 016. This project was completed in 2016.
- **Infiltration/Inflow Removal Project –** The design and construction of sewer and manhole rehabilitation to remove inflow and infiltration in the State Street sewershed in Hamden upstream of Regulators 009 and 015. This project was also completed in 2016.

The ITCP was the focus of this CSO LTCP update. Preliminary Design Reports were generated for the East Street, Union, and Boulevard Pump Stations. These controls will provide immediate CSO reduction upon completion, but will be fully utilized once the Phase II improvements are made to the ESWPAF to allow for treatment of increased flows. The controls included in the ITCP are listed below and shown on Figure ES-1.

- **Capacity Upgrade of East Street Pump Station –** The design and construction of upgrades to the East Street Pump Station to provide flood protection, improve reliability and increase pumping capacity from 30 to 65 mgd. Pumping capacity will be limited to 40 mgd until the Phase II ESWPAF improvements are complete.
- **Yale Campus Trumbull Street Area Phase 2A Project Sewer Separation (CWF 2009-04) –** The construction of a combined sewer separation project that proposes to install new separate storm drains and to reuse the existing combined sewer as a sanitary sewer system in order to reduce CSO frequency, duration and volume at CSO outfall 011. The project consists of approximately 7,125 linear feet of storm piping ranging in diameter from 15 to 42 inches and a green infrastructure component that includes the construction of several bioswales. Design has been completed and utility relocation is underway.
- **Capacity Upgrade of Union Pump Station –** The design and construction of upgrades to the Union Pump Station and force main to provide flood protection, improve reliability and increase pumping capacity to 35 mgd. Pumping capacity will be limited to 15 mgd until the Phase II ESWPAF improvements are complete.
- **Capacity Upgrade of Boulevard Pump Station –** The design and construction upgrades to Boulevard Pump Station to provide flood protection, improve reliability and increase pumping capacity to 45 mgd. Pumping capacity will be limited to 30 mgd until the Phase II ESWPAF improvements are complete.

The LTCP is scheduled to be completed by 2040. These controls will provide the final improvements to meet the goal of the Consent Order and will allow the three major pump stations to operate at full capacity with the wet weather improvements made to the ESWPAF. The controls included in the LTCP are listed below and shown on Figure ES-1.

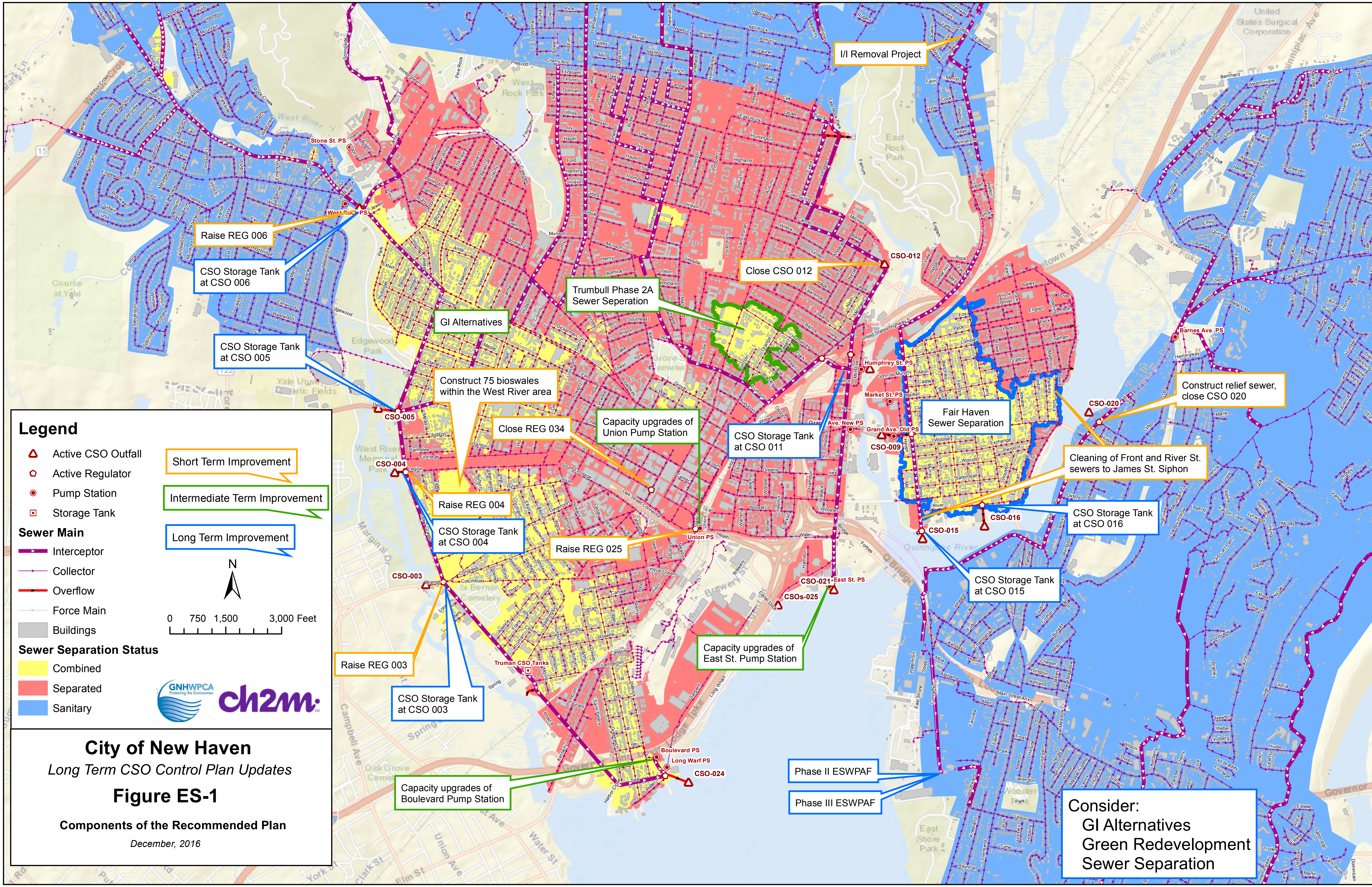
- **Phase II and III East Shore WPAF Wet Weather Capacity Improvements –** Design and construction of wet weather improvements to provide flood protection, improve reliability and upgrade treatment capacity to 160 mgd. These improvements include upgrades to Headworks, Preliminary Treatment, Primary Treatment, Incineration, Nitrogen Removal (IFAS), Disinfection, Odor Control, and Power Distribution to new facilities in order to maximize treatment of wet weather flows at the East Shore WPAF.
- **Fair Haven Sewer Separation Project –** The design and construction of sewer separation of 365 acres of sewershed in Fair Haven in order to reduce CSO frequency, duration and volume at CSO outfalls 009, 015 and 016.
- **CSO Storage Tanks –** The design and construction of CSO storage tanks totaling 5.7 MG at the following CSO outfalls: 003 (0.1 MG), 004 (0.7 MG), 005 (1.7 MG), 006 (1.3 MG), 011 (1.3 MG), 015

(0.4 MG), and 016 (0.2 MG) in order to capture CSOs resulting from wet weather events up to and including the 2-year, 6-hour design storm.

The next CSO LTCP Update scheduled for 2022 will focus on the Long Term Improvements including Phase II Wet Weather Capacity Improvements to the ESWPAF. The 2028 CSO LTCP Update will focus on the Phase III Improvements at the ESWPAF and the initial phases of the sewer separation in Fair Haven. The final CSO LTCO Update scheduled for 2034 will include the final phases of the sewer separation in Fair Haven and planning for the CSO Storage Tanks. Each future CSO LTCP Update will evaluate the effectiveness of the components of the plan in terms of the CSO reduction and consider alternatives to incorporate lessons learned and new technologies that may become available in order to eliminate CSOs for the 2-year, 6-hour storm by 2040.

Plan Implementation Schedule and Costs

Project cost estimates for the components of the recommended plan were generated based on the level of detail known at the time this report was prepared. The complete cost estimate summary and schedule is shown on Figure ES-2. All project cost estimates are expressed in 2016 dollars and include an estimate of construction costs, contingencies, and an allowance for engineering and administrative costs. Figure ES-2 also includes the anticipated grant percentage and amount from the Clean Water Fund, the City of New Haven's 40 percent share of the CWF loan and the GNHWPCA's 60 percent share of the CWF loan.



City of New Haven

Long Term CSO Control Plan Updates

Figure ES-1

Components of the Recommended Plan

December, 2016

CSO LONG TERM CONTROL PLAN IMPLEMENTATION SCHEDULE AND PROJECT COST ESTIMATE

CSO LTCP COMPONENTS	Million (2016 $)	Grant %	CWF Grant	NH Loan Share	GNH Loan Share	2016	2017	2018	2019	2020	2021	2022	2023-2028	2029- 2034	2035 - 2040
2016 Long Term Control Plan Update															
Short Term Improvements (2016-2018)	***$ 10.4***														
Regulators 012 and 020 Relief Sewers (CWF 2016-02)	5.4	50%	2.7	1.1	1.6										
West River CSO Improvements (CWF 2016-03)	2.5	50%	1.3	0.5	0.8										
Regulator 034 Relief Sewer (CWF 2016-05)	1.0	50%	0.5	0.2	0.3										
Green Infrastructure Improvements (CWF 2016-07)	1.5	50%	0.8	0.3	0.5										
Intermediate Term Improvements (2018-2028)	***$ 98.7***														
Capacity Upgrade of East Street Pump Station	34.8	50%	17.4	7.0	10.4										
Yale Campus/Trumbull Street Phase 2A Separation (CWF 2009-04)	12.0	50%	6.0	2.4	3.6										
Capacity Upgrade of Union Pump Station	17.0	50%	8.5	3.4	5.1										
Capacity Upgrade of Boulevard Pump Station	34.4	50%	17.2	6.9	10.3										
2022 Long Term Control Plan Update	0.5	55%	0.3	0.1	0.1										
Long Term Improvements (2024-2040)	***$323.9***														
Phase II ESWPAF Wet Weather Capacity Improvements	134.2	40%	53.7	32.2	48.3										
2028 Long Term Control Plan Update	0.5	55%	0.3	0.1	0.1										
Phase III ESWPAF IFAS/Incinerator Improvements	34.5	23%	8.1	0.0	26.4										
2034 Long Term Control Plan Update	0.5	55%	0.3	0.1	0.1										
Fair Haven Sewer Separation	94.4	50%	47.2	18.9	28.3										
CSO Storage Tanks/Separation/GI Alternatives	59.8	50%	29.9	12.0	17.9										
Elimination of CSOs during a 2-year, 6 hr storm	**$433.0**	**45%**	**$194.0**	**$85.0**	**$154.0**										

Figure ES-2. CSO Long-Term Control Plan Implementation Schedule and Project Cost Estimate

SECTION 1

Introduction to the Plan

1.1 Objectives

Pursuant to Consent Order WC5509, the Authority has agreed to update the City of New Haven's *Combined Sewer Overflow Long-Term Control Plan* (CSO LTCP) every 5 years. The last update to the LTCP was approved by DEEP in 2011. The Authority updated the Hydraulic Model in 2014 and completed the 2015 Hydraulic Model Update report. The 2015 Hydraulic Model Update report documents updates to the Authority's collection system hydraulic model including the upgrade to the latest modeling platform, the expansion of the model domain, updates to the modeling components. The completion of a comprehensive flow monitoring program, enabled the calibration, validation, system optimization of the hydraulic model.

In July of 2015, the DEEP and the Authority negotiated a modification to Consent Order WC5509. The Consent Order modifications memorialized the schedule for GNHWPCA to complete its Long-Term Control Plan Update (LTCP) and subsequent updates, and requires the construction of the improvements identified in such updates to achieve CSO control.

The Authority is being assisted by CH2M to update the 2011 LTCP under an On-Call Engineering Service Contract, Task Order CH2M 16 – Long-Term Control Plan Update, dated December 15, 2015. The purpose of this LTCP Update is to incorporate the findings concluded in the 2015 Hydraulic Model Update report and investigate potential alternatives to meet the 2-year, 6-hour level of service and provide the five-year update to the LTCP as per the Consent Order.

1.2 Project Background

Prior to 1997, the City of New Haven (City) separated approximately 35 percent of its combined sewers, as recommended in the 1981 Facilities Plan and the 1988 update. In 1997, the City commissioned a report, the New Haven *Long-Term CSO Control Plan*, to reduce the overall costs of constructing CSO controls to meet the guidance provided in the U.S. Environmental Protection Agency's (USEPA's) CSO Control Policy of April 1994, and produce the documentation required for CSO-related issues described in the New Haven Water Pollution Control Authority's (NHWPCA, the predecessor agency to GNHWPCA) National Pollutant Discharge Elimination System (NPDES) permit.

In April 2001, the *City of New Haven Long-Term Combined Sewer Overflow Control Plan* was developed in collaboration with the Connecticut Department of Environmental Protection (CT DEP) and a broad group of stakeholders. The report provided a description of CSOs that were active as of 1997, the discharges from these CSOs during a 2-year, 6-hour storm event, and a series of recommendations, both short- and long-term, to reduce CSOs in the future.

In March 2003, the report was approved by DEEP and the program to eliminate all CSOs during a 2-year, 6-hour storm event was adopted.

In 2005, the GNHWPCA was created to provide service to 200,000 customers in New Haven, Hamden, East Haven, and Woodbridge. The sewer system in the City of New Haven consists of approximately 70 miles of combined sewers, 70 miles of separated sewers, and 155 miles of sanitary sewers. There are approximately 260 miles of sanitary sewers in Hamden, East Haven, and Woodbridge. The Authority entered into a cost-sharing agreement with the City whereby the costs for CSO-related work would be shared 60/40, with 40 percent being the City's share. In 2005, the Authority also entered into an agreement with the City and the Towns of Hamden, East Haven and Woodbridge to purchase their sewer systems pump stations.

In May 2008, a series of reports prepared for GNHWPCA documented the progress made in reducing CSOs for the 10-year period between 1997 and 2007.

In July 2009, the Authority entered into a Consent Order with the CT DEEP for execution of the LTCP that would eliminate all CSOs during a 2-year, 6-hour storm event.

In November 2009, the LTCP Update was prepared and documented the required infrastructure improvements necessary to receive and treat the additional CSOs at the East Shore WPAF. The report also consolidated, in the form of appendices, the 2001 LTCP report and the many subsequent reports supporting the LTCP Update.

In March 2011, the LRP Update was approved by CT DEEP.

The LTCP Update is the guidance document used to track the requirements of the Consent Order entered into by CT DEEP and the Authority. Under the terms of the Consent Order, the Authority will invest in the infrastructure necessary to comply with the USEPA's CSO Control Policy. This LTCP Update presents a summary of the progress of implementing the LTCP, and updates the planned improvements still to be constructed. LTCP updates represent a tool to modify the LTCP as new information and experience is obtained that affects the philosophy and strategies being pursued. CT DEEP approval of the LTCP updates is an acceptance of these changes.

In 2015, the Hydraulic Model update was approved by CT DEEP. The findings concluded in the 2015 Hydraulic Model Update report have been incorporated into the 2016 LTCP Update.

Listed below all the improvements made by the GNHWPLA to the combined sewer system between 2009 and 2015.

- The REG 004 weir was raised 8 inches
- The REG 005 weir was raised 1.45 feet
- CSO 008 was closed
- CSO 010 was closed
- The REG 012 weir was raised 6 inches
- CSO 013 was closed
- REG 014 was closed
- REG 031 was closed
- REG 032 was closed
- The REG 034 weir was raised 2 feet
- The Greene Street REG was closed
- A new duckbill was installed at the CSO 015 outfall
- A new duckbill was installed at the CSO 016 outfall
- Two new duckbills were installed at the CSO 021 outfall
- A new tidegate was installed at the CSO 024 outfall
- Lombard Street East Sewer Separation Project was completed
- Yale Campus/Trumbull Street Area –Phases 1A and 1B Sewer Separation Projects were completed
- Improvements were made to the Truman CSO Storage Tanks by lowering the connection between the two tanks by 8.5 feet

- The Lower Boulevard Trunk Sewer was cleaned

Through the efforts of the City and the Authority between 1997 and 2015, CSO volumes have been reduced by 46% during the 2-year, 6-hour design storm (From 26 mg to 14mg) and by 66% during the Typical Year (From 126 mg over 51 events to 43 mg over 30 events.)

SECTION 2

Nine Minimum Control (NMC) Measures

2.1 Objectives

The modification of the Consent Order WC5509 between the DEEP and the GNHWPCA requires the documentation of the Nine Minimum Controls (NMCs); including the summarizing of the status of the control measures.

2.2 Project Background

Combined sewer systems (CSSs) carry a mixture of sanitary sewage and stormwater to a treatment facility via a single pipe. During wet weather, wastewater flows can exceed the capacity of the CSS and/or treatment facilities. In such an event, sewers are designed to overflow directly to surface water bodies, such as lakes, rivers, estuaries, or coastal waters. These overflows, called combined sewer overflows (CSOs), can be a source of water pollution.

As an effort to combat CSOs, the Environmental Protection Agency (EPA) issued the CSO Control Policy on April 11, 1994. One aspect of the policy is the NMCs, which are CSO-reducing measures that do not require significant engineering studies or major construction.

The NMCs are:

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 publicly owned treatment works (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 that the public receives adequate notification of CSO occurrences and CSO impacts.
9) Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

CH2M has completed an update to the NMCs Implementation Assessment included in the City of New Haven’s 2001 CSO LTCP. This updated assessment of the Authority’s implementation of the NMC measures followed EPA’s May 1995 Guidance for Nine Minimum Controls Document.

For each of the NMCs, we have summarized the status of control measures implemented and looked to identify any deficiencies that would require future corrective action by the Authority in Appendix A.

Based on our assessment, we find that the Authority is in full compliance with implementation of the NMCs and that no corrective action is required at this time.

The Authority should continue to assess and update their programs that support implementation of the NMCs many of which are listed below.

- CSO Flow Monitoring Program

- Monthly inspections of CSO regulators, CSO outfalls AND DUCKBILLS
- Hydraulic Model Update
- Emergency Response Plan
- Regulator improvement program
- Capacity, Management, Operations and Maintenance (CMOM) Plan
- Large diameter sewer cleaning program
- Wet weather operational plan at the ESWPAF
- CSO reporting using DEEP's website

The Authority should also continue to work closely with the City of New Haven regarding pollution prevention measures such as catch basin cleaning and street sweeping.

Model Update to 2016 Conditions

3.1 Basis of the Baseline Conditions Model

The baseline model is used as the standard against which all control strategies are measured. Alternatives evaluations rely on the baseline conditions model to accurately reflect existing conditions to avoid inaccurate benefits of the control strategies. The 2014 Conditions Model used in the 2015 Hydraulic Model Update was updated to include all the changes to the system since 2014. With these changes, the model calibration is still valid.

The two rainfall conditions, the 2-year 6-hour design storm and the Typical Year, are used to evaluate system performance. During the 2001 LTCP report, these two rainfall conditions were evaluated and established. Due to climate change and increased extreme weather, these two rainfall conditions change over time and need to be re-evaluated. Detailed documentation of the storm re-evaluation is presented in Appendix B and summarized in Sections 3.1.1 and 3.1.2.

3.1.1 The 2-year, 6-hour design storm

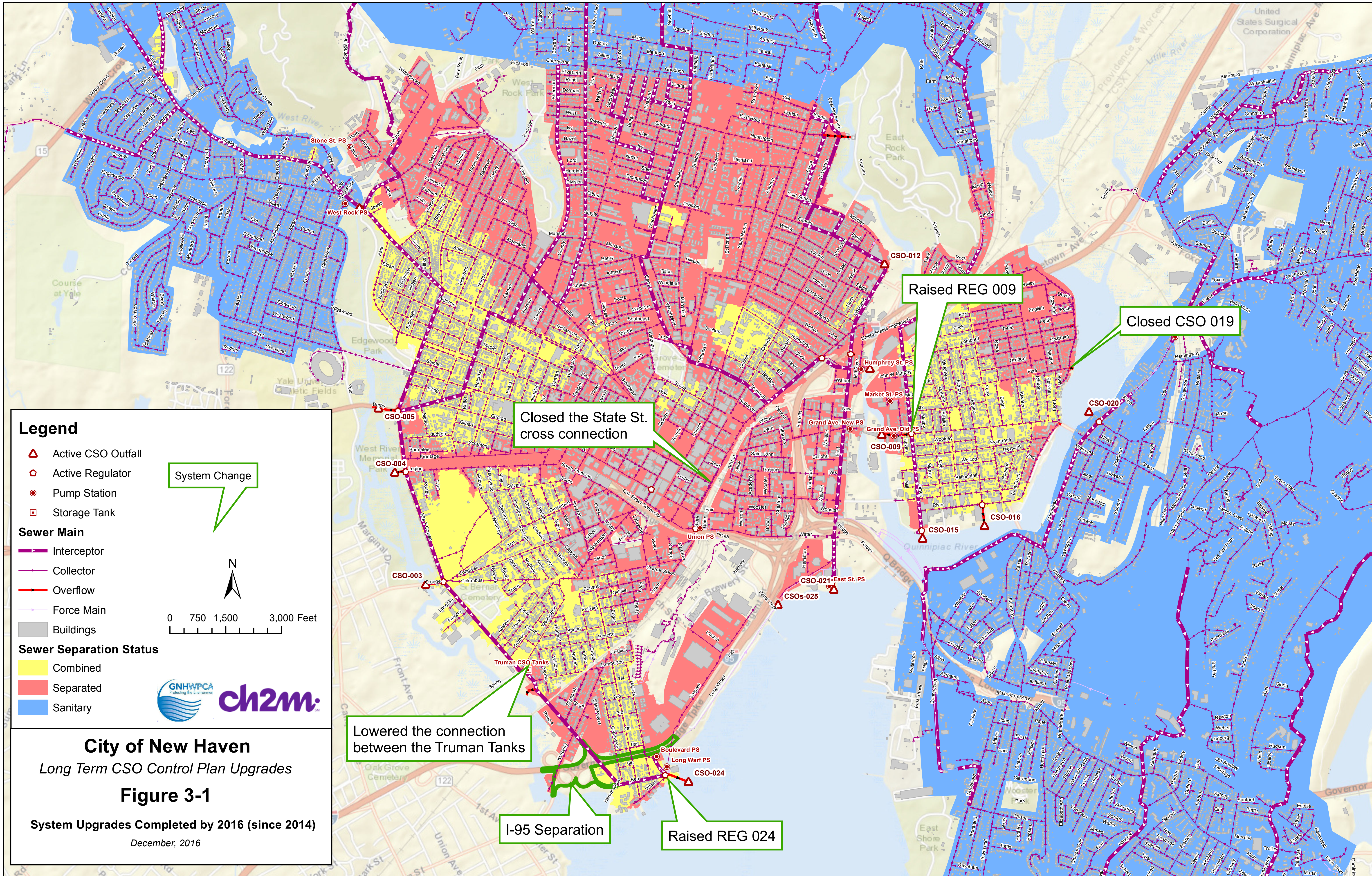
Based on IDF curves generated by Cornell University and the Northeast Regional Climate Center (NRCC) approximately between the period of 1955 and 2014, the 2-year 6-hour storm has since increased from 2.05 inches to 2.13 inches. Based on the storm template developed in 2001, the design storm was adjusted to the increased volume. The peak 15-minute intensity has now increased from 2.15 in/hr to 2.23 in/hr. This updated storm is used for this LTCP Update.

3.1.2 Typical Year

Rainfall data from several rain gages close to New Haven was obtained, reviewed and statistically examined to find a representative Typical Year. The 2001 LTCP established 1967 as the Typical Year. After the new rainfall data was incorporated and all the statistical analysis was completed, 1967 still has all the qualities of a Typical Year.

3.2 System Changes

The changes to the system since 2014 include closure of CSO 019, raising the weir at REG 009 by 8 inches, raising the weir at REG 024 by 1.56 ft, lowering the connection between the two cells of the Truman CSO Storage Tank by 8.5 feet, I-95 storm sewer separation and closure of the storm and combined line cross-connection at the intersection of State Street and Chapel Street. The changes made to the modeled system are shown in Figure 3-1.



City of New Haven

Long Term CSO Control Plan Upgrades

Figure 3-1

System Upgrades Completed by 2016 (since 2014)

December, 2016

3.2.1 State/Chapel Cross-Connection Recalibration

A cross-connection was discovered between the combined system and a storm drain network near the intersection of State Street and Chapel Street that was unknown during the 2014 model calibration. The cross-connection exists between a 90-inch storm drain and a 24-inch combined sewer leading to REG 025. The 18-inch overflow pipe invert is set to begin overflowing once flow in the storm drain reaches 53 percent capacity. The cross-connection is shown in Figure 3-2. This connection was not represented in the 2014 model, and therefore parameters in the model required a recalibration.

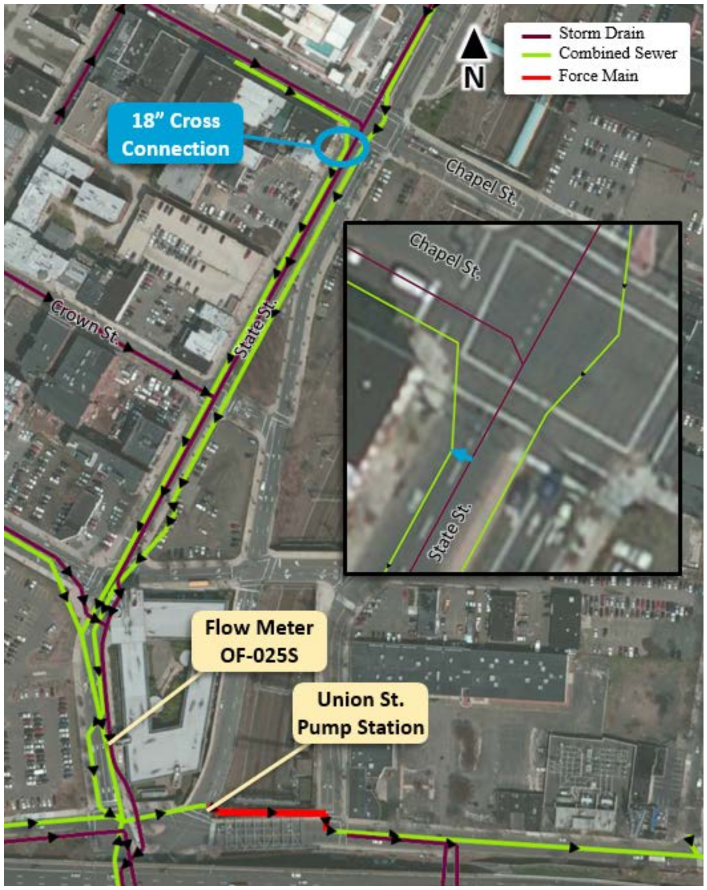


Figure 3-2. State St./Chapel St. Cross Connection
Location of the discovered cross connection between the combined and storm drain systems

This connection was closed on April, 6, 2016.

3.2.2 I-95 Separation

A segment of I-95 near the southern tip of New Haven was recently separated from the combined system in the Boulevard pump station sewershed. This area is shown below in Figure 3-3 and has an approximate drainage area of 25 ac (19 ac impervious and 6 ac pervious). Because this is a model correction, the model again requires recalibration.

Figure 3-3. I-95 Separation
Displays the area of I-95 that was recently separated

For recalibration, the original calibration model from 2014 was used. Because this area falls at the downstream end of the Boulevard pump station sewershed, no other downstream areas needed to be adjusted accordingly for this recalibration. The meters in this area include OF-024 US and OF-024 DS. Under the 2016 conditions model during the 2-year, 6-hour design storm, separation of this area provided a net benefit of 0.27 MG reduction in CSO volume along the Boulevard Trunk Sewer CSOs.

3.3 2016 Conditions Performance

The 2016 Conditions Model scenario was run for the 2-year, 6-hour design storm as well as the Typical Year. The system changes have effectively reduced CSO volumes, as shown in Figures 3-4 and 3-5, and Tables 3-1 and 3-2 from 2014 conditions. Under the 2014 conditions, the system discharged 15.9 million gallons (MG) of CSO during the 2-year 6-hour design storm and 43.4 MG of CSO over 30 discrete CSO events (147 systemwide total events) under the Typical Year. These changes reduce CSO volume by an additional 10 percent during the design storm to 14.3 MG and 26 percent during the Typical Year to 32.3 MG over 27 discrete CSO events (110 systemwide total events).

The largest benefit was seen along the Boulevard Trunk Sewer. Raising the weir at REG 024 along with the lowering of the Truman Tank connection, provided a net reduction in overflow volume of 1.6 MG along the Boulevard Trunk Sewer CSOs. In Fair Haven, CSO 019 was closed and the weir at REG 009 was raised. These modifications primarily affect the distribution of overflows volumes in Fair Haven and not the total overflow volume.

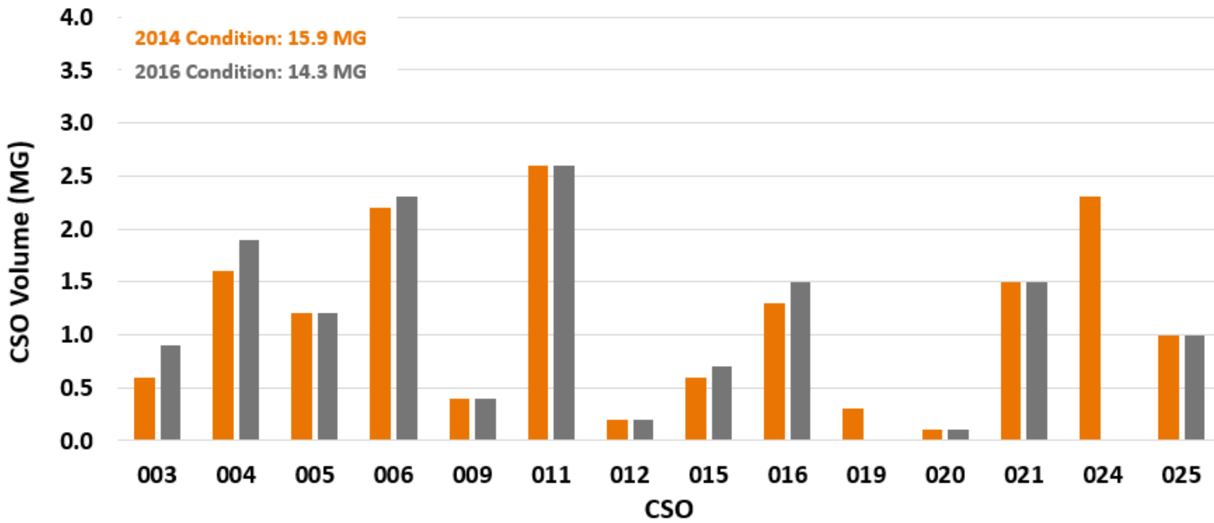


Figure 3-4. System Performance under 2016 Conditioning during the Design Storm
Comparison of system performance between 2014. Conditions and 2016 conditions during the 2-year, 6-hour design storm

Table 3-1. System Performance under 2016 Conditions during the Design Storm
Overflow volume from all the active CSOs

Receiving Water	CSO Outfall	CSO Volume (MG)	
		2014	2016
West River	003	0.6	0.9
	004	1.6	1.9
	005	1.2	1.2
	006	2.2	2.3
	Subtotal	**5.6**	**6.3**
Mill River	009	0.4	0.4
	011	2.6	2.6
	012	0.2	0.2
	Subtotal	**3.2**	**3.2**
Quinnipiac River	015	0.6	0.7
	016	1.3	1.5
	019	0.3	Closed
	020	0.1	0.1
	Subtotal	**2.3**	**2.3**
New Haven Harbor	021	1.5	1.5
	024	2.3	0.0
	025	1.0	1.0
	Subtotal	**4.8**	**2.5**
	Systemwide Total	**15.9**	**14.3**

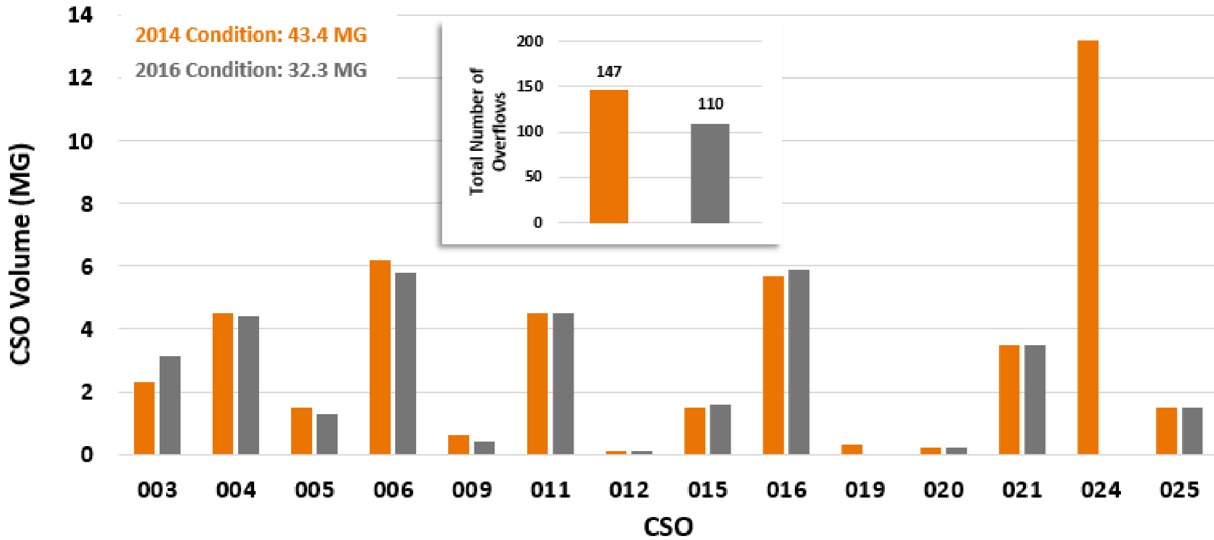


Figure 3-5. System Performance under 2016 Conditions during the Typical Year

Comparison of system performance between 2014. Conditions and 2016 Conditions during the Typical Year

Table 3-2. System Performance under 2016 Conditions during the Typical Year

Overflow volume and frequency from all the active CSOs

Receiving Water	CSO Outfall	2014		2016	
		CSO (MG)	**Events**	**CSO (MG)**	**Events**
West River	003	2.3	17	3.1	15
	004	4.7	22	4.4	19
	005	1.5	6	1.3	6
	006	6.2	11	5.8	9
	Subtotal	**14.6**	**56**	**14.6**	**49**
Mill River	009	0.6	5	0.4	3
	011	4.3	8	4.5	6
	012	0.1	2	0.1	2
	Subtotal	**5.0**	**15**	**5.0**	**11**
Quinnipiac River	015	1.5	9	1.6	9
	016	5.7	30	5.9	27
	019	0.3	3	Closed	Closed
	020	0.2	5	0.2	5
	Subtotal	**7.7**	**47**	**7.7**	**41**
New Haven Harbor	021	1.2	6	3.5	6
	024	13.5	17	0.0	0
	025	1.5	6	1.5	3
	Subtotal	**16.2**	**29**	**5.0**	**9**
	Systemwide Total	**43.4**	**147**	**32.3**	**110**

Short-Term CSO Control Plan

4.1 Basis of the Short-Term Control Plan

The Short-Term CSO Control Plan (STCP) includes system upgrades which were initiated in 2016 and are expected to be complete by 2018. This is the first of three milestones to remove or control CSO discharge from all CSO outfalls resulting from wet weather events up to and including the 2-year, 6-hour design storm for the service area by 2040. These controls were developed in the 2015 Hydraulic Model Update, and are currently under design. The majority of these controls utilize available in-system storage and small scale gray and green projects to optimize the system at relatively low costs. The following sections detail the progress of each control and the system performance under this control plan.

4.2 STCP Controls

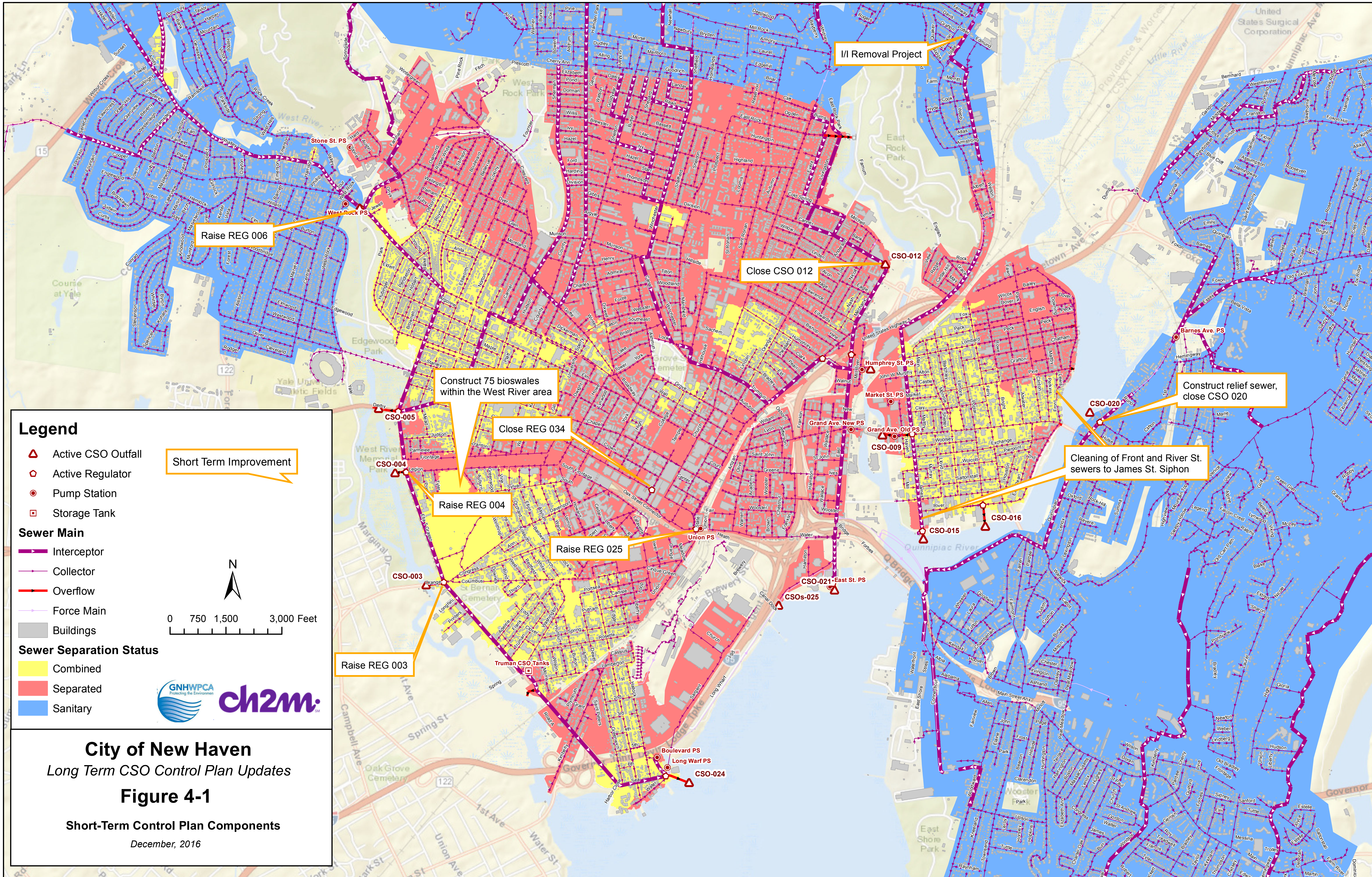
The controls included in the STCP are construction of relief sewers; closure of CSO 012, CS0 020, and REG 034; raising the weirs at REG 003, REG 004 and REG 006 by 3 feet; raising the weir at REG 025 to prevent stormwater inflow to the sewer system by 9.15 feet; cleaning of the Front and River Street larger diameter sewers in Fair Haven; constructing 75 bioswales within the West River sewershed, and the implementation of an I/I reduction project along State Street in Hamden. The STCP improvements are shown in Figure 4-1.

Most of the short-term controls are in the course of design development. Two of the projects were completed in 2016. A summary of the status of each project is as follows:

Short-term Improvements

- **Regulators 012 and 020 Relief Sewers (CWF 2016-02) –** The design and construction of individual relief sewer segments and regulator improvements to reduce CSO frequency, duration and volume at CSO outfalls 012 and 020. The preliminary design has been completed and the detail design is currently underway.
- **Regulator 034 Regulator Improvements (CWF 2016-05) –** The design and construction of regulator improvements to reduce CSO frequency, duration and volume at CSO regulator 034 and CSO outfall 025. The preliminary design has been completed and the detail design is currently underway.
- **Green Infrastructure Improvements (CWF 2016-07) –** The design and construction of approximately 75 bioswales along City streets within combined sewer areas in the West River watershed to reduce the CSO frequency, duration and volume to the West River. The preliminary design has been completed and the detail design is currently underway.
- **West River CSO Improvements (CWF 2016-03) –** The design and construction of improvements and modifications to Regulators 003, 004 and 006 along the Boulevard Trunk Sewer to reduce CSO discharges to the West River. The preliminary design has been completed and the detail design is currently underway.
- **Cleaning of Front and River Street Sewers –** The inspection and cleaning of sewers along Front and River Street to the James Street Siphon to increase conveyance and capacity. This project was completed in 2016.

- **Infiltration/Inflow Removal Project –** The design and construction of sewer and manhole rehabilitation to remove inflow and infiltration in the State Street sewershed in Hamden upstream of Regulators 009 and 015. This project was also completed in 2016.



City of New Haven

Long Term CSO Control Plan Updates

Figure 4-1

Short-Term Control Plan Components

December, 2016

4.3 STCP Performance

The STCP model scenario was run for the 2-year, 6-hour design storm as well as the Typical Year. The control plan effectively reduced CSO volumes, as shown in Figures 4-2 and 4-3, and Tables 4-1 and 4-2 from 2016 Conditions. Under the 2016 Conditions, the system discharges 14.3 MG of CSO during the 2-year, 6-hour design storm and 32.3 MG of CSO over 27 discrete CSO events (110 systemwide total events) under the Typical Year. Completion of the STCP projects will reduce CSO volumes by an additional 15 percent during the design storm to 12.1 MG and 39 percent during the Typical Year to 19.6 MG.

Similar to the 2014/2016 transition, the largest benefit seen under this condition will be with the Boulevard Trunk Sewer CSOs to the West River. These regulator changes will fully optimize the Boulevard Trunk Sewer and provide another 1.9 MG reduction of CSO volume in the 003, 004, 005, and 006 CSOs. CSO volume from CSO 024 to New Haven Harbor will increase by 0.8 mg as a result of the West River regulator improvements. In Fair Haven, the sewer cleaning on Front and River Streets to the James Street Siphon will divert the overflows downstream from CSO 016 to CSO 015 due to the increased conveyance while also reducing Fair Haven CSO volume by 0.1 MG. The raising of the weir at REG 025 will reduce stormwater inflow by 0.3 MG during the design storm and prevent CSOs at this regulator.

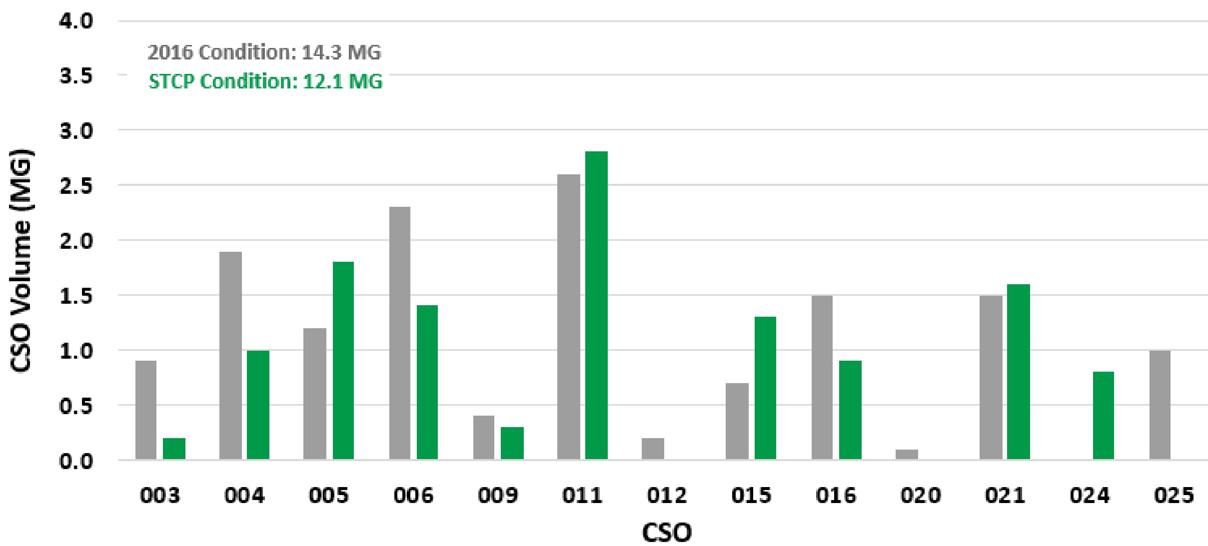


Figure 4-2. System Performance under the STCP during the Design Storm

Comparison of system performance between 2016 Conditions and the STCP during the 2-year, 6-hour design storm

Table 4-1. System Performance under the STCP during the Design Storm

Overflow volume from all the active CSOs

Receiving Water	CSO Outfall	CSO Volume (MG) 2016	CSO Volume (MG) STCP
West River	003	0.9	0.2
	004	1.9	1.0
	005	1.2	1.8
	006	2.3	1.4
	Subtotal	**6.3**	**4.4**
Mill River	009	0.4	0.3

Table 4-1. System Performance under the STCP during the Design Storm

Overflow volume from all the active CSOs

Receiving Water	CSO Outfall	CSO Volume (MG)	
		2016	STCP
	011	2.6	2.8
	012	0.2	Closed
	Subtotal	**3.2**	**3.1**
Quinnipiac River	015	0.7	1.3
	016	1.5	0.9
	020	0.1	Closed
	Subtotal	**2.3**	**2.2**
New Haven Harbor	021	1.50	1.6
	024	0.0	0.8
	025	1.0	0.0
	Subtotal	**2.5**	**2.4**
	Systemwide Total	**14.3**	**12.7**

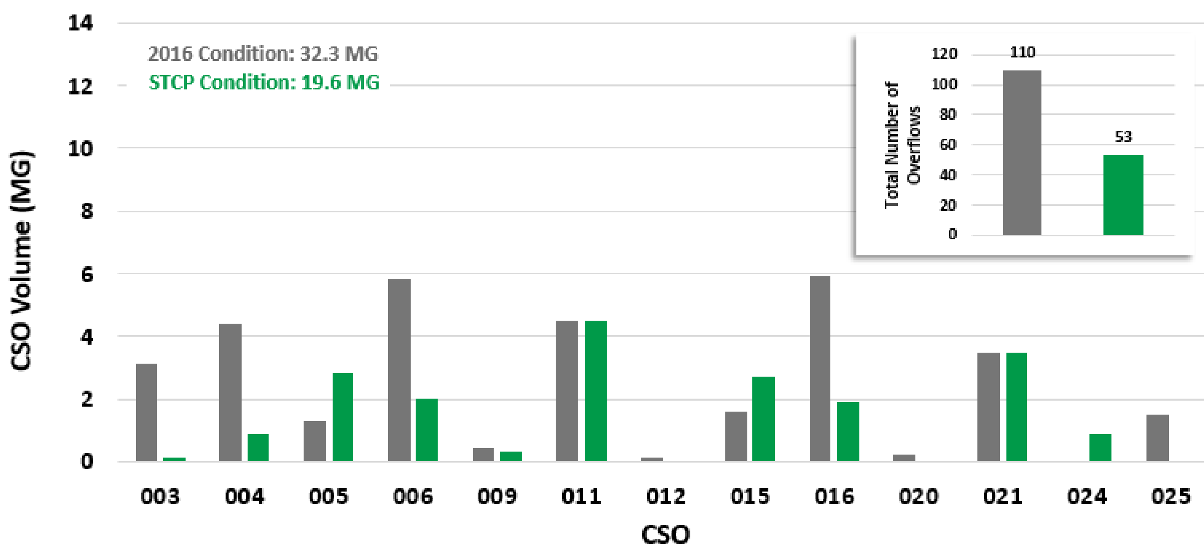


Figure 4-3. System Performance under the STCP during the Typical Year

Comparison of system performance between 2016 conditions and the STCP during the Typical Year

Table 4-2. System Performance under the STCP during the Typical Year

Overflow volume and frequency from all the active CSOs

Receiving Water	CSO Outfall	2016		STCP	
		CSO (MG)	Events	CSO (MG)	Events
West River	003	3.1	15	0.1	2
	004	4.4	19	0.9	5
	005	1.3	6	2.8	6
	006	5.8	9	2.0	6
	Subtotal	**14.6**	**49**	**5.8**	**19**

Table 4-2. System Performance under the STCP during the Typical Year
Overflow volume and frequency from all the active CSOs

		2016		STCP	
Receiving Water	**CSO Outfall**	**CSO (MG)**	**Events**	**CSO (MG)**	**Events**
Mill River	009	0.4	3	0.3	2
	011	4.5	6	4.5	6
	012	0.1	2	Closed	Closed
	Subtotal	**5.0**	**11**	**4.8**	**8**
Quinnipiac River	015	1.6	9	2.7	8
	016	5.9	27	1.9	8
	020	0.2	5	Closed	Closed
	Subtotal	**7.7**	**41**	**4.6**	**16**
New Haven Harbor	021	3.5	6	3.5	6
	024	0.0	0	0.9	3
	025	1.5	3	0.0	0
	Subtotal	**5.0**	**9**	**4.4**	**9**
	Systemwide Total	**32.5**	**110**	**19.0**	**53**

Under the STCP, the maximum potential total flow to the East Shore WPAF is 110 mgd during the 2-year, 6-hour design storm. The system flow diagram is shown below in Figure 4-4.

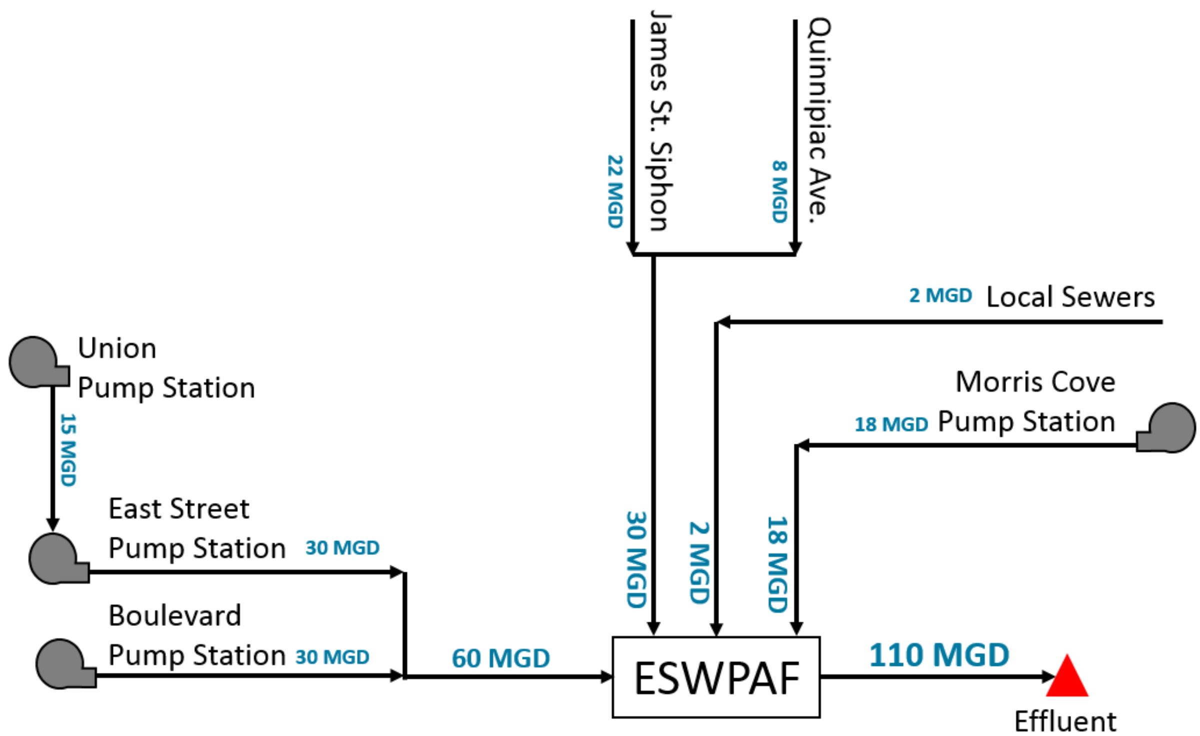


Figure 4-4. STCP Flow Diagram
Potential flows received by the East Shore WPAF under the STCP during the 2-year 6-hour design storm

Intermediate-Term CSO Control Plan

5.1 Basis of the Intermediate-Term Control Plan

The Intermediate-Term CSO Control Plan (ITCP) includes system upgrades which are expected to be initiated in 2018 and complete by 2028 are the primary focus of this 2016 LTCP Update. This is the second of three milestones to remove or control CSO discharge from all CSO outfalls resulting from wet weather events up to and including the 2-year, 6-hour design storm for the service area by 2040. These improvements create CSO reduction benefits as described below.

5.2 ITCP Controls

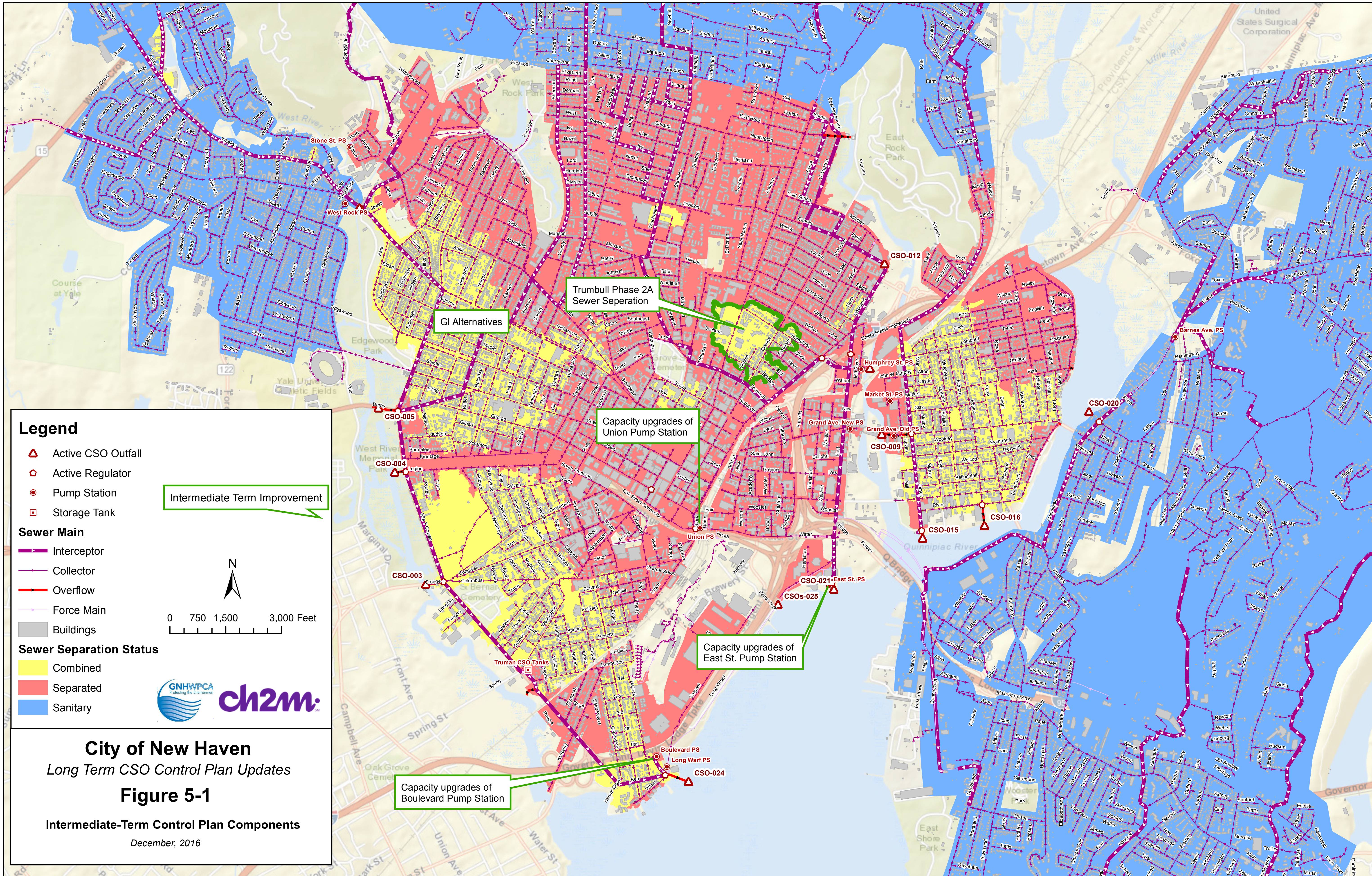
The controls included in the ITCP are the Yale/Trumbull Phase 2A Sewer Separation project and capacity upgrades at East Street, Union and Boulevard, Pump Stations. Design of the Yale/ Trumbull Phase 2A project is completed and utility relocation is underway. The ITCP improvements are shown in Figure 5-1.

One of the main objectives of the Intermediate-Term Improvements is to upgrade the three major pump station infrastructure in order to maximize conveyance of wet weather flows to the East Shore WPAF for treatment. These intermediate improvements are intended to provide capacity improvements, flood resiliency and improved reliability at East Street, Union and Boulevard Pump Stations.

Models were developed to calculate how much flow can be conveyed to the wet well of each of the three major pump stations using the existing and upgraded infrastructure and to evaluate improvements to each major pump station to allow the station to carry the design flows. The process mechanical, electrical, and appurtenant facilities at all three major pump stations are recommended for a complete rehabilitation. Due to the significant interaction of all three major pump stations with each other, hydraulic, pump system, and force main analysis and an alternatives evaluation were conducted on all three major pump stations to capture the interactions between each. Section 5.4 through 5.5 describe this analysis and summarize the recommended improvements to each of the three major stations. Included in Appendices C, D, and E are separate preliminary design reports for East Street, Union and Boulevard Pump Stations.

5.3 ITCP Performance

The ITCP model scenario was run for the 2-year, 6-hour design storm as well as the Typical Year. Although some of these improvements are directed more toward the future, some CSO reduction is achieved as shown in Figures 5-2 and 5-3, and Tables 5-1 and 5-2 from the STCP. Under the STCP, the system discharges 12.1 MG of CSO during the 2-year, 6-hour design storm and 19.6 MG of CSO over 8 discrete CSO events (53 systemwide total events) under the Typical Year. Completion of the ITCP projects reduces CSO volume by an additional 22 percent during the design storm to 9.4 MG and 35 percent during the typical year to 12.8 MG over 8 discrete CSO events (45 systemwide total events). While the sewer separation project and upgrades to the East Street Pump Station provides significant CSO reduction, the majority of these controls provide high potential CSO reduction once the East Shore WPAF Phase II and III Improvements are completed for increased treatment capacity under the LTCP.



City of New Haven

Long Term CSO Control Plan Updates

Figure 5-1

Intermediate-Term Control Plan Components

December, 2016

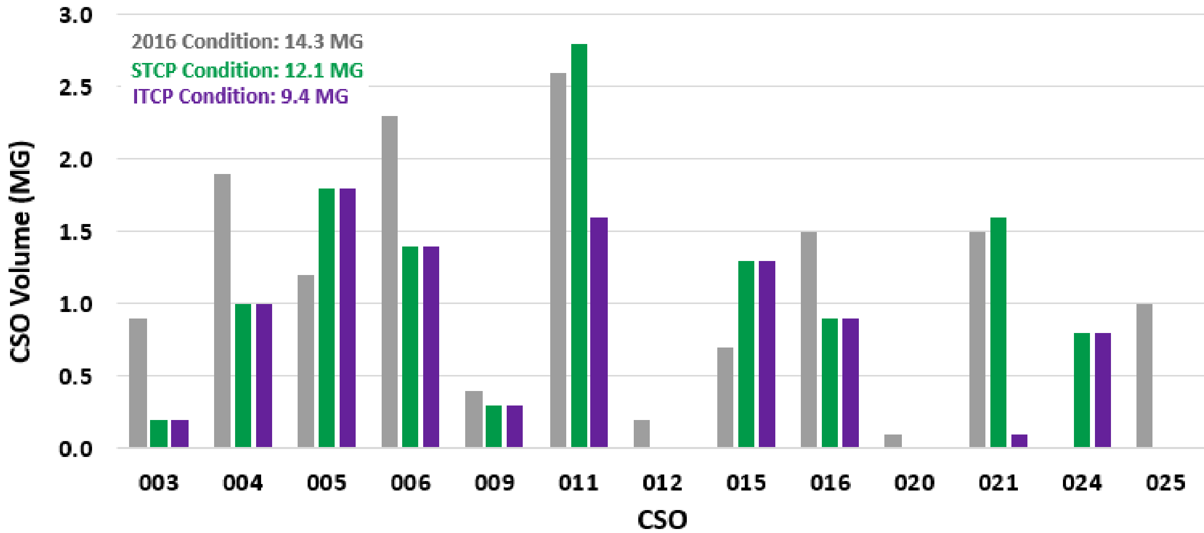


Figure 5-2. System Performance under the ITCP during the Design Storm
Comparison of system performance between 2016 Conditions, the STCP and the ITCP during the 2-year 6-hour design storm

Table 5-1. System Performance under the ITCP during the Design Storm
Overflow volume from all the active CSOs

Receiving Water	CSO Outfall	CSO Volume (MG)		
		2016	STCP	ITCP
West River	003	0.9	0.2	0.2
	004	1.9	1.0	1.0
	005	1.2	1.8	1.8
	006	2.3	1.4	1.4
	Subtotal	**6.3**	**4.4**	**4.4**
Mill River	009	0.4	0.3	0.3
	011	2.6	2.8	1.6
	012	0.2	Closed	Closed
	Subtotal	**3.2**	**3.1**	**1.9**
Quinnipiac River	015	0.7	1.3	1.3
	016	1.5	0.9	0.9
	020	0.1	Closed	Closed
	Subtotal	**2.3**	**2.2**	**2.2**
New Haven Harbor	021	1.5	1.6	0.1
	024	0.0	0.8	0.8
	025	1.0	0.0	0.0
	Subtotal	**2.5**	**2.4**	**0.9**
	Systemwide Total	**14.3**	**12.1**	**9.4**

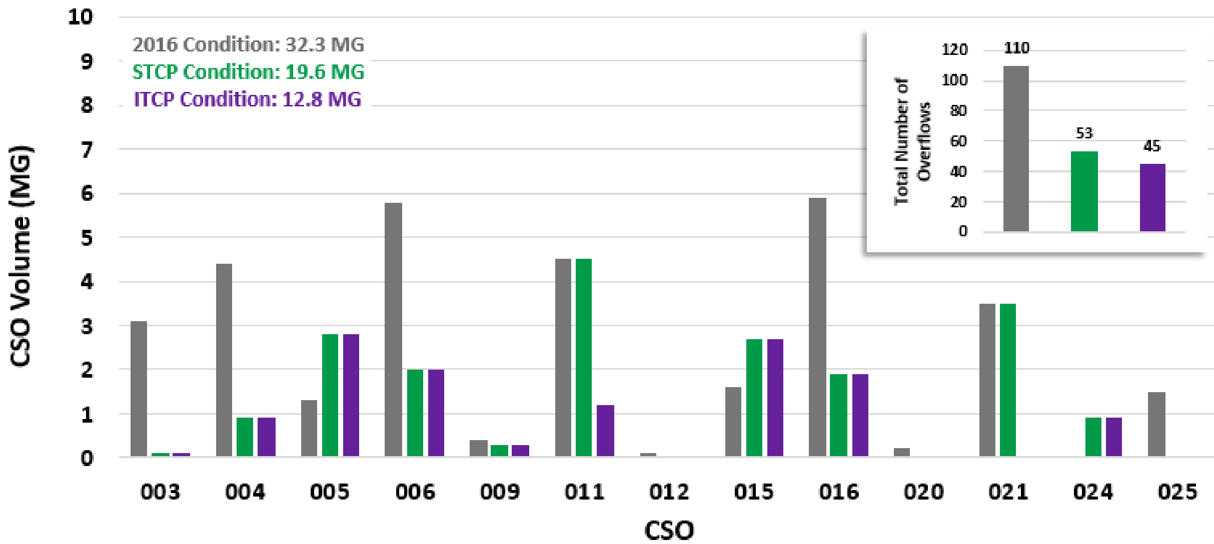


Figure 5-3. System Performance under the ITCP during the Typical Year

Comparison of system performance between 2016 Conditions, the STCP and the ITCP during the Typical Year

Table 5-2. System Performance under the ITCP during the Typical Year

Overflow volume from all the active CSOs

Receiving Water	CSO Outfall	2016		STCP		ITCP	
		CSO (MG)	Events	CSO (MG)	Events	CSO (MG)	Events
West River	003	3.1	15	0.1	2	0.1	2
	004	4.4	19	0.9	5	0.9	5
	005	1.3	6	2.8	6	2.8	6
	006	5.8	9	2.0	6	2.0	6
	Subtotal	**14.6**	**49**	**5.8**	**19**	**5.8**	**19**
Mill River	009	0.4	3	0.3	3	0.3	3
	011	4.5	6	4.5	6	1.2	4
	012	0.1	2	Closed	Closed	Closed	Closed
	Subtotal	**5.0**	**11**	**4.8**	**9**	**1.5**	**7**
Quinnipiac River	015	1.6	9	2.7	8	2.7	8
	016	5.9	27	1.9	8	1.9	8
	020	0.2	5	Closed	Closed	Closed	Closed
	Subtotal	**7.7**	**41**	**4.6**	**16**	**4.6**	**16**
New Haven Harbor	021	3.5	6	3.5	6	0.0	0
	024	0.0	0	0.9	3	0.9	3
	025	1.5	3	0.0	0	0.0	0
	Subtotal	**5.0**	**9**	**4.4**	**9**	**0.9**	**3**
	Systemwide Total	**32.3**	**110**	**19.6**	**53**	**12.8**	**45**

Under the ITCP, the maximum potential total flow to the East Shore WPAF is 120 mgd during the 2-year, 6-hour design storm. The system flow diagram is shown below in Figure 5-4. The Intermediate-Term flows that will get to the ESWPAF are listed while the ultimate Long-Term capacities of the pump stations are listed in parentheses. These ultimate capacities will be utilized to maximize wet weather flows to the ESWPAF for treatment following the ESWPAF Phase II Wet Weather Capacity Improvements in the Long-Term phase.

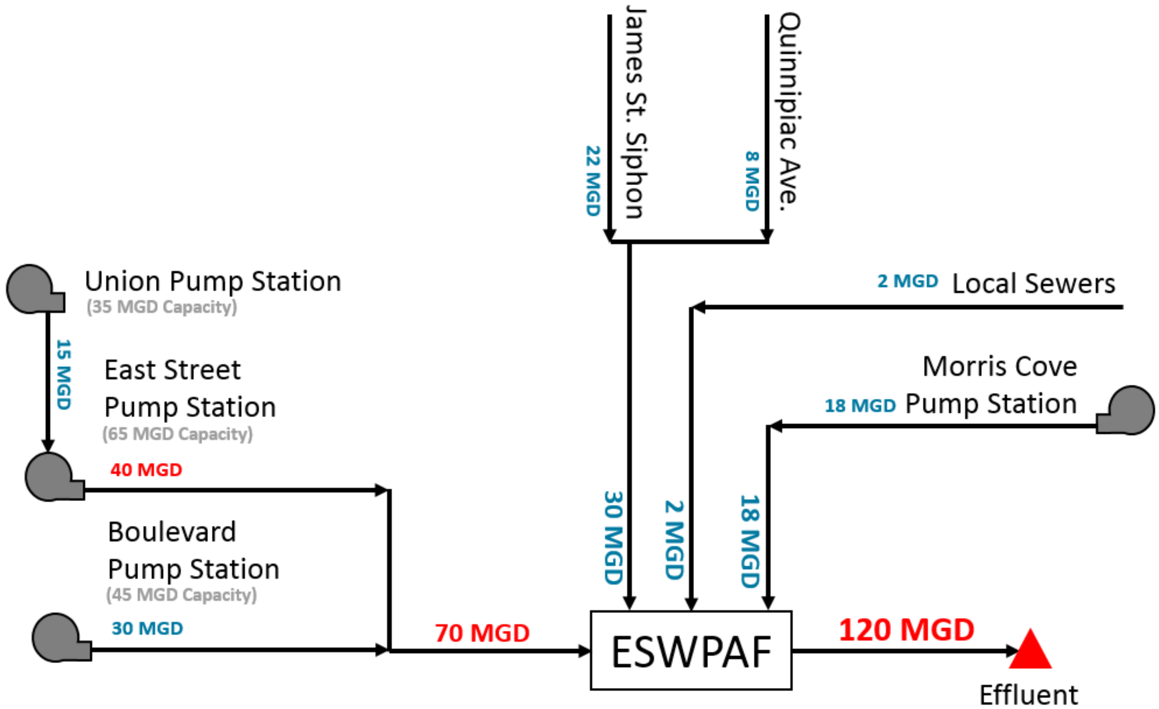


Figure 5-4. ITCP Flow Diagram

Potential flows received by the East Shore WPAF under the ITCP during the 2-year, 6-hour design storm

5.4 Pump Station Alternatives Evaluation

The 2015 Hydraulic Model Update described a plan to utilize the existing pump station infrastructure to convey wet weather flow within each sewershed to the East Shore WPAF in order to eliminate CSOs for the 2-year, 6-hour storm.

The modified Consent Order calls for the Union Pump Station Capacity Upgrades including a dedicated wet weather force main to be designed and constructed to assist in CSO reductions. The Union Pump Station was originally designed to convey combined sewer flow over the railroad tracks and into the gravity drainage system along Water Street. The flow eventually reached the East Street Pump Station where it was pumped via a force main to the East Shore WPAF. The Union Pump Station's capacity is currently limited to 15 mgd due to downstream capacity restrictions at the East Street Pump Station. However, the ultimate capacity of the Union Pump Station was designed to be 35 mgd. The original Intermediate- and Long-Term plan was to construct a dedicated force main to the Harbor Crossing. As will be discussed in subsequent sections, the design progression identified new options that provide for more efficient capture of CSO flows while improving operability and constructability of this element of the LTCP at a lower cost.

5.4.1 Pump Station Force Main Evaluation and Modeling

Two additional flow models were developed for each of the three major pump stations to identify what improvements are necessary to meet the design flows developed using the 2016 Conditions Hydraulic Model. Improvements necessary to convey the design flows by gravity from the sanitary sewer through each of the three major pump stations screening and grit systems to the wet well were identified by computing a hydraulic profile using CH2M’s proprietary software, WinHydro. The hydraulic model was prepared using available mechanical, structural, and civil plan-and-profile record drawings, site visits, and photos. Improvements to each of the three existing pump stations pumping capacity and force mains were identified through incompressible pipe flow modeling using AFT Fathom version 8.0. The hydraulic model was prepared using available mechanical, structural, and civil plan-and-profile record drawings and photos. Boulevard Pump Station utilizes a 36-inch force main to convey flow and connects into the 42-inch force main from the East Street Pump Station. The East Street and Boulevard combined flows converge in a 48-inch force main and travel towards the double 42-inch barrel Harbor Crossing force mains. The models were used to analyze two alternatives for conveying the flows from Union Pump Station to the East Shore WPAF.

1. Provide a new dedicated 30-inch force main from Union Pump Station via a new utility bridge across Metro-North to join the combined East Street and Boulevard 48-inch force main upstream of the double barrel 42-inch Harbor Crossing. The new force main would only convey wet weather flows. Dry weather flows would continue to be pumped to East Street Pump Station via replacements to the existing 24-inch force main and the existing utility bridge across Metro-North in the same location.
2. Utilize the replacements to the existing 24-inch force main and the existing utility bridge across Metro-North in the same location and the existing gravity sewer infrastructure in Water Street to convey both dry and wet weather flows from Union Pump Station to East Street Pump Station.

5.4.2 Union Pump Station Force Main Alternative 1 – Dedicated Force Main to the Harbor Crossing

Under Alternative 1 the Union Pump Station would be upgraded to convey 35 mgd to the 48-inch force main upstream of the Harbor Crossing. The flows would be limited to 15 mgd in the Intermediate-Term until the Phase II upgrades to the ESWPAF are completed. Dry weather flows would continue to be pumped to East Street Pump Station via replacements to the existing 24-inch force main and the existing utility bridge across Metro-North in the same location and the existing gravity sewer infrastructure in Water Street.

The existing four pumps would be replaced with five pumps, two dry weather and three wet weather. The pump discharge pipes would combine into a common header inside the dry well. Valves on the header would allow for the pumps to send flow to either the new 30-inch force main or the East Street Pump Station. During dry weather, flows would be pumped to the Water Street gravity system which flows to the East Street Pump Station.

The Alternative 1 Intermediate-Term flow diagram for a 2-year 6-hour design storm is presented below in Figure 5-5.

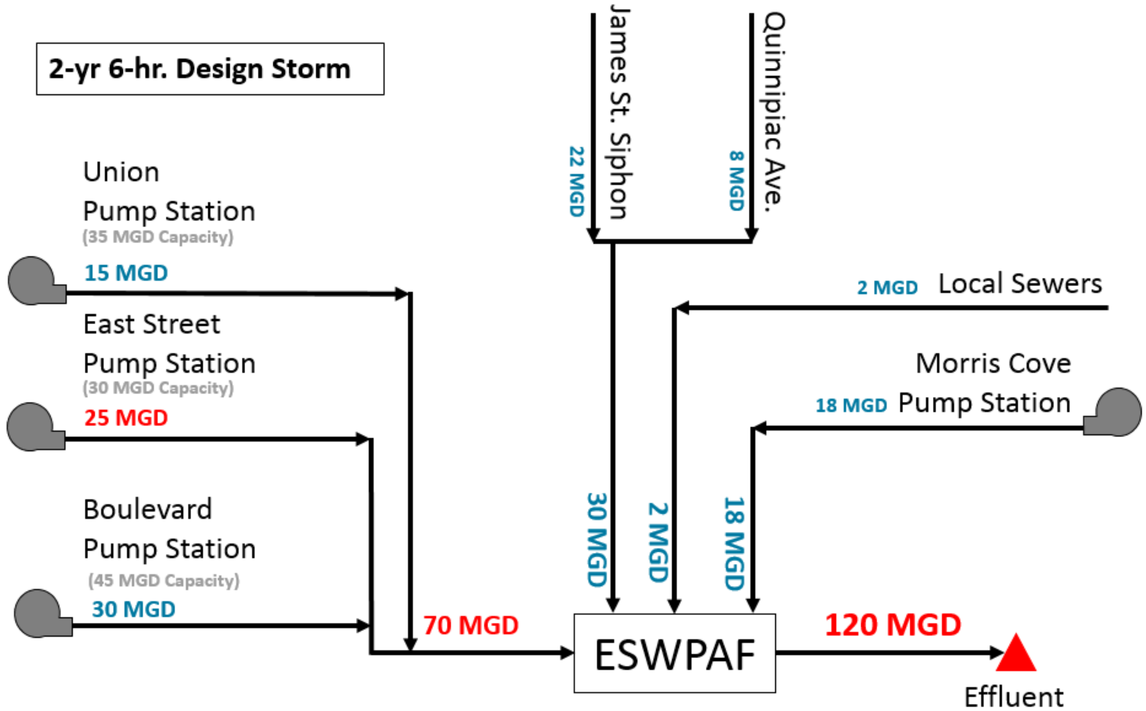


Figure 5-5. ITCP Alternative 1 Flow Diagram

Potential flows received by the East Shore WPAF under the ITCP during the 2-year, 6-hour design storm for Alternative 1

The new dedicated 30-inch force main from the Union Pump Station would join the 48-inch force main just upstream of the double barrel 42-inch Harbor Crossing. Hydraulic modeling showed that the dedicated wet weather force main increases the total dynamic head (TDH) at Union Pump Station and drops the TDH at East Street and Boulevard Pump Stations. The increase at Union Pump Station is due to the longer force main and head necessary to pump against the flow from East Street and Boulevard Pump Stations. The drop in TDH at East Street and Boulevard Pump Stations are a result of the decrease in flows from East Street Pump Station. Under the Intermediate-Term flows, the increase at Union Pump Station is offset by the drop at East Street Pump Station and Boulevard Pump Station for a net TDH that is the same under both alternatives. As the flows increase, the rise in TDH at Union Pump Station becomes significant causing the net TDH under Alternative 1 to be approximately 30% higher than Alternative 2 under the Long-Term flows.

Operational constraints dictate the need for the use of two force mains under Alternative 1. The low flows during dry weather would not generate high enough velocities in the new wet weather force main to prevent deposition of solids. Additionally, the flows in the Water Street gravity sewer are too low to create flushing velocities without the contribution from the Union Pump Station force main. These issues would require the new force main to only be in operation during wet weather to ensure adequate velocities are maintained and flows would be pumped to the Water Street gravity system during dry weather to provide scouring. Operational protocols would be required to manage the cyclic operation of the wet weather force main.

The existing 24-inch force main discharging to the Water Street gravity system crosses the Metro-North Railroad on a steel truss utility bridge. The force main is wrapped in insulation and supported on pipe rollers. The bridge also supports a 16-inch high pressure gas main. The bridge was constructed in 1960 and recent inspections indicate there are structural deficiencies that require rehabilitation or replacement. The existing 24-inch force main is also in need of replacement under both Alternatives 1 and 2.

Metro-North requires new pipelines located over, under, across, or upon railroad property over which the railroad operates to be encased in a casing pipe a minimum of four inches greater than the outside diameter of the carrier pipe. The casing pipe must be isolated from the carrier pipe by approved isolators.

Two options were explored for addressing the structural issues at the pipe bridge, the first rehabilitates the existing bridge in-place and the second replaces the bridge in its entirety.

The first option addresses the structural condition by strengthening the structure for the increase load of the casing pipe and addresses structural deficiencies identified during inspection. It would require the existing force main to be removed during the work requiring bypass pumping throughout the duration of the rehabilitation. All work would need to be performed over active railroad tracks requiring the majority of the work to be completed at night during short windows when Metro-North Railroad would allow access. The estimated cost for rehabilitating the bridge in place and replacement of the existing 24-inch force main is $2.8M.

The second option would replace the bridge in the same location. The new bridge would be constructed offsite and installed with the use of a crane. A short duration bypass would be necessary while the existing bridge is removed and the new one set in place. The bridge could be constructed with new materials that would reduce maintenance and extend the life of the structure. There is limited room to operate a large crane in the bridge location requiring power outages, closing of nearby streets, temporary support of a pole with a guy wire passing through a truss for an existing bridge and close coordination with Metro-North Railroad, Southern Connecticut Gas Company and the City of New Haven. The estimated cost for replacing the existing bridge and replacing the existing 24-inch force main is $2.2M.

Replacing the utility bridge (Option two) is the recommended option moving forward under Alternative 1 or 2 because it will provide a more durable structure with less disruption to railroad operations and reduces costs and schedule risks associated with working above the railroad.

CH2M initiated a route planning study to select the most optimum route for the new 30-inch wet weather force main. Under this scenario, a second pipe bridge is required to support the new 30-inch force main across the railroad tracks for wet weather flows. Due to the highly urbanized nature of the area, very little space is available to route a new force main. There were two potential east/west corridors available for use; Chapel Street and Water Street. Figures 5-6 and 5-7 show potential routes for Chapel Street and Water Street, respectively. Of the routes available, the 5600-foot Water Street alignment was the most feasible due to the recent expansion of the I-95 Interstate as well as significant utility upgrades and relocations to support new bridge foundations.

Cost estimates for Alternatives 1 and 2 are presented in Section 5.4.4.

Figure 5-6. Water Street Force Main Route

Figure 5-7. Chapel Street Force Main Route

5.4.3 Union Pump Station Force Main Alternative 2 – Maximizing Use of Existing Infrastructure

Under Alternative 2 the Union Pump Station would be upgraded to convey 35 mgd to the East Street Pump Station. The flows would be limited to 15 mgd in the Intermediate-Term until the Phase II upgrades to the ESWPAF are completed. The existing 24-inch force main and the existing utility bridge across Metro-North would be replaced in the same location.

The existing four pumps would be replaced with five pumps, two dry weather and three wet weather. The pump discharge pipes would combine into a common header inside the dry well before exiting the station. All flows are conveyed to East Street Pump station via the new 24-inch force main and the Water Street gravity sewer.

The Alternative 2 Intermediate-Term flow diagram for a 2-year 6-hour design storm is presented below in Figure 5-8.

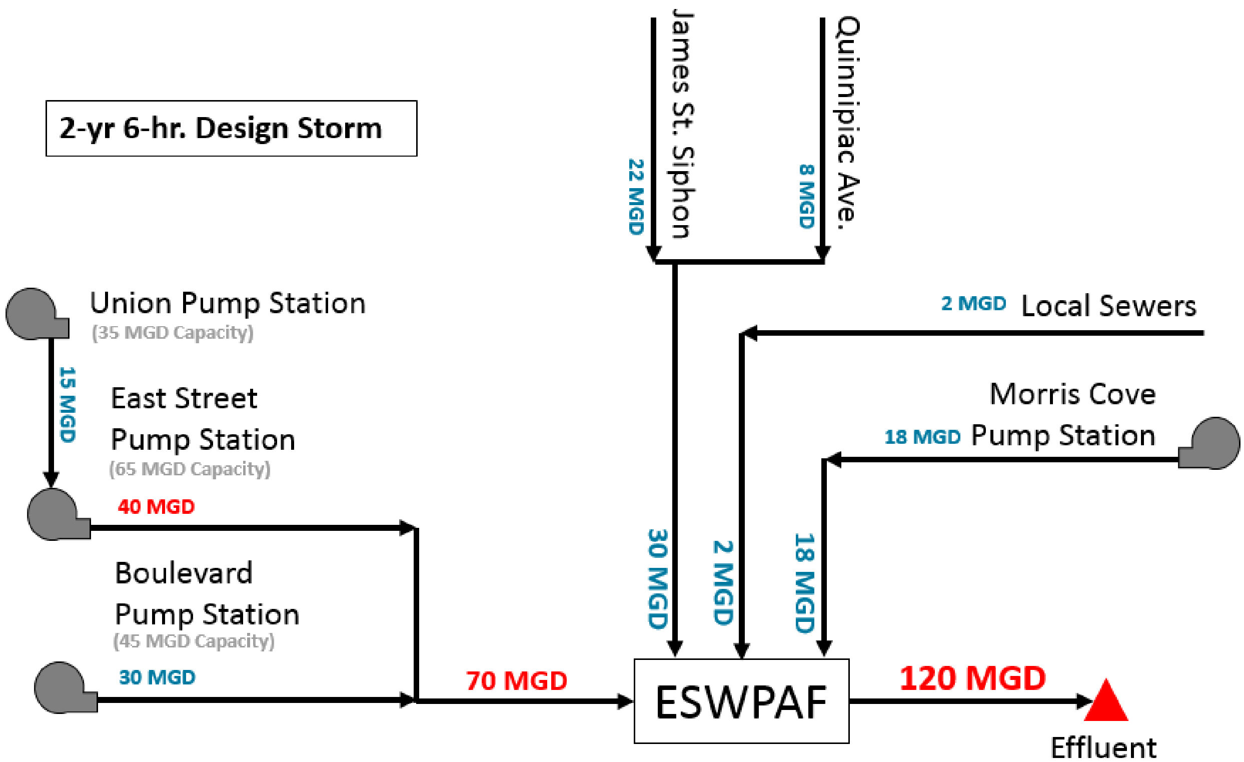


Figure 5-8. ITCP Alternative 2 Flow Diagram

Potential flows received by the East Shore WPAF under the ITCP during the 2-year, 6-hour design storm for Alternative 2

CH2M obtained as-built information on the rehabilitation and relocation of utilities along Water Street related to bridge and roadway construction activities completed in 2011. This information showed that the gravity sewer line had been replaced and/or relined for much of its length. On the downstream end as it approached East Street, some segments had also been upsized. The hydraulic model was updated to account for these improvements resulting in a higher conveyance capacity. Current modeling indicates that the Water Street gravity sewer can convey the peak flow of 35 mgd from Union Pump Station to East Street Pump Station without overtopping manholes or backing up other gravity sewer systems. Modeling indicates that the installation of a watertight cover on manholes NEA03M0077 and NEA03M0078 at the corner of Water Street and Olive Street will be provided to further ensure there will not be street flooding.

Figure 5-9 shows the approximately one-mile-long gravity sewer route along Water and East Street from Union Pump Station to East Street Pump Station.

Figure 5-9. Gravity Sewer route along Water and East Street

Figure 5-10 shows the hydraulic profile along Water and East Street during the 2-year 6-hour Design Storm for Alternative 1. The profile does not include any flow contribution from Union Pump Station as all 35 mgd of wet weather flows are in the dedicated 30-inch force main to the Harbor Crossing. This hydraulic profile is presented as a baseline of the Water Street gravity system.

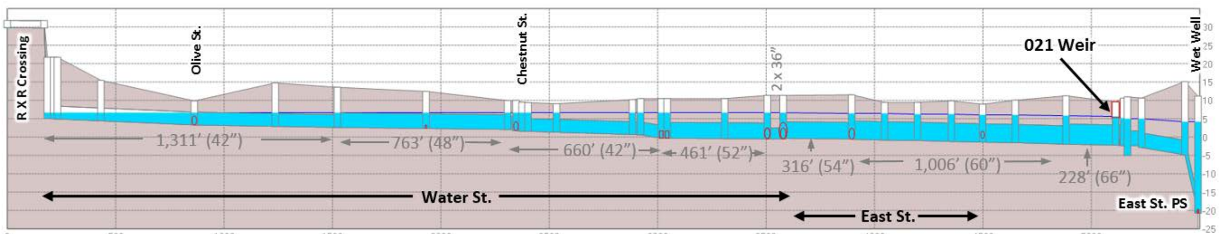


Figure 5-10. Hydraulic Profile along Water and East Street – Alternative 1

Figure 5-11 shows the hydraulic profile along Water and East Street during the 2-year 6-hour Design Storm for Alternative 2. The profile includes 35 mgd from Union Pump Station. The figures show the addition of Union Pump Station flows raises the hydraulic profile slightly but does not overtop manholes.

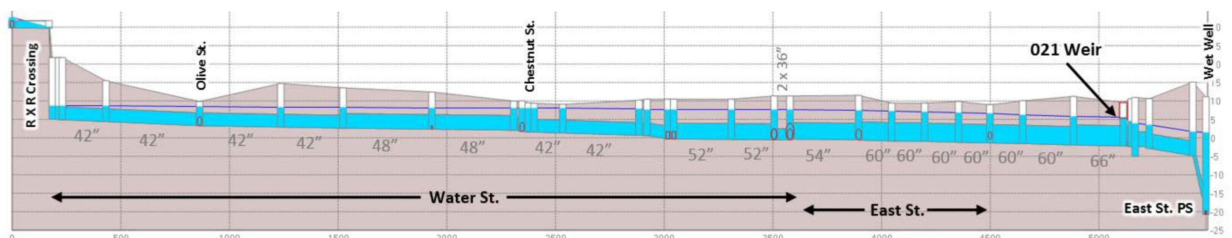


Figure 5-11. Hydraulic Profile along Water and East Street – Alternative 2

During the peak flow events, the gravity flow moving towards the East Street Pump Station backs up in the lower sections of the Water Street gravity sewer. This condition will exist only when the combined sewer flows from the East Street sewershed are timed to directly peak with flow from the Union Pump Station sewershed in the hydraulic model, which is highly unlikely. Understanding this new option, CH2M re-evaluated the current pumping philosophy at the East Street Pump Station.

The East Street Pump Station was originally a full primary treatment plant prior to construction of the East Shore WPAF. In the mid-1980s the process components of the plant were demolished and the effluent pump station was retrofitted to convey flow to the East Shore WPAF. At that time, it was designed for 40 mgd capacity but design plans showed the capability of expansion to a 65 mgd capacity. Further process design modeling confirmed that the station could convey up to 65 mgd allowing the East Street Pump Station to manage all required flows from its sewershed and that of Union Pump Station, thus achieving the objective of eliminating CSO discharges during the 2-year, 6-hour storm event.

5.4.4 Cost Implications for Alternatives

A Class 5 cost estimate was generated to examine the project cost differences between the two alternatives. A Class 5 cost estimate has an accuracy between -20 and +100 percent. The estimates were generated to get an order of magnitude difference between the two alternatives so that costs could be considered with other advantages and disadvantages.

The construction and project costs for Alternative 1 are presented in Table 5.3.

Table 5-3. Construction and Project Costs of Alternative 1

Description	Unit	$/Unit	Cost
Union and East Street Pump Station upgrades	EA	$ 24,000,000	$ 24,000,000
30-inch force main to the Harbor Crossing	LF	$ 5,600	$ 30,000,000
Construction Cost			**$ 54,000,000**
Engineering and Administrative			$ 11,000,000
Project Cost			**$ 65,000,000**

The construction and project costs for Alternative 2 are presented in Table 5.4.

Table 5-4. Construction and Project Costs of Alternative 2

Description	Unit	$/Unit	Cost
Union and East Street Pump Station upgrade	EA	$ 29,000,000	$ 29,000,000
Construction Cost			**$ 29,000,000**
Engineering and Administrative			$ 6,000,000
Project Cost			**$ 35,000,000**

The 30-inch force main to the Harbor Crossing and the new utility bridge over Metro-North under Alternative 1 would cost $30M to construct. This cost is not included under Alternative 2 but the increase in flows to East Street Pump Station under the alternative results in an increase in the construction cost at East Street of $5M. The increase accounts for larger pumps, larger electrical gear, and an increase in the size of the electrical room. As shown in the above tables the project cost for Alternative 2 is $30 million less than Alternative 1.

5.4.5 Recommended Alternative

The recommended alternative for Union Pump Station is Alternative 2. This alternative alleviates the operational difficulties related to a separate wet weather force main, reduces required process equipment sizes and maximizes the use of existing infrastructure. This alternative also eliminates the costly construction and constructability issues identified during the force main route evaluation.

The modified Consent Order calls for the design and construction of the Union Pump Station Capacity Upgrades to occur first under the Intermediate-Term upgrades followed by the Yale/Trumbull Phase 2A sewer separation project. Upgrades to East Street and Boulevard Pump Stations would follow. It is recommended to modify this schedule to upgrade East Street Pump Station first. STCP regulator modifications at 025 will reduce CSOs. Increasing capacity at Union Pump Station will not result in additional CSO reductions until the Phase II ESWPAF capacity upgrades are complete allowing Union Pump Station to increase its capacity to 35 mgd. Upgrades to East Street Pump Station increases the capacity of the station under the Intermediate-Term from 30 to 40 mgd which reduces CSOs at Outfalls 011 and 021 immediately.

Table 5.5 displays the different flow scenarios at each pump station under the Short-Term, Intermediate-Term, and Long-Term scenarios.

Table 5-5. Flow Scenarios

Pump Station	Short-Term Flows (mgd)	Intermediate-Term Flows (mgd)	Long-Term Flows (mgd)
Union (to East Street)	15	15	35
East Street	30	40	65
Boulevard	30	30	45

5.5 Preliminary design of East Street, Union, and Boulevard Pump Stations

The recommended rehabilitation of the pump stations addresses flood protection, improved reliability and the required increase in pumping capacity for each station. This section outlines the scope of rehabilitation at each station that is detailed in the Preliminary Design Reports in Appendices C, D and E.

5.5.1 Resiliency Planning and Design Basis

As part of its recognition of future coastal resiliency impacts, the State of Connecticut has directed that all projects using State funding, such as the Clean Water Fund (CWF), must include features that address potential sea level rise and coastal resiliency issues within its design. Each of these stations are either within or directly adjacent to the 100-year floodplain, as determined by the Federal Emergency Management Agency (FEMA). The current Flood Insurance Rate Maps (FIRMs) for the New Haven area have recently been updated as a result of documented impacts from Hurricane Sandy, and recent regional evaluations of sea level rise trends and future projections. Due to this revision, the regulatory base flood elevations have risen by 1 foot at both East Street and Boulevard Pump Stations, but remain the same for Union Pump Station.

In accordance with the Public Act No. 13-15, the CWF is required to consider the necessity and feasibility of implementing measures designed to mitigate the impact of a rise in sea level over the projected life span of such a project. To further the abilities of municipalities to implement this requirement, the New England Interstate Water Pollution Control Commission (NEIWPCC) updated its *Technical Release 16, Guides for the Design of Wastewater Treatment Works* (TR-16) and provided guidance on selecting an appropriate protection elevation related to the criticality of each process component and the impact on the environment if that process was affected during a storm event. The guidance document separates facilities into two types: critical and non-critical. Critical facilities are defined as those systems that are required for the conveyance of wastewater to and through a treatment facility. This includes all electrical, mechanical, and control systems within a pump station. The recommendation in TR-16 is to elevate these critical elements a minimum of 3 feet above the 100-year flood elevation.

As part of the recent Phase I Wet Weather Capacity Improvements and Nitrogen Reduction Project at the East Shore WPAF, an evaluation was conducted to establish the resiliency elevation for use during this construction project. This evaluation included consideration of recent regional coastal sea level rise evaluations, along with elevating equipment above the 500-year flood elevation. Combining these two elements resulted in a protection elevation for the East Shore WPAF of 2.95 feet (NAVD 88) above the established 100-year base flood elevation. As part of this LTCP Update, the protection elevation is being set at 3 feet to be consistent with the TR-16 guidance.

In general, each station was evaluated for the feasibility and necessity of elevating critical equipment to maintain operations during a flooding event. It was deemed not feasible or cost-effective to elevate all equipment due to existing space limitations, or overall station configuration. In addition, due to the interconnectivity of the station with existing outfalls adjacent to the stations, certain areas will be inundated without the ability to protect the interior of the facilities from rising flood waters. For this purpose, GNHWPCA has taken the approach of providing dry floodproofing where critical equipment must remain below the resiliency protection elevation, and providing wet floodproofing where appropriate to maintain structural stability and allow the facility to quickly regain full operations once the flood waters recede. Specific floodproofing methods will be described within the specific pump station design discussions. All measures protect critical facilities up to 3 feet above the established 100-year flood elevation.

5.5.2 East Street Pump Station Intermediate Improvements

Intermediate-Term improvements at the East Street Pump Station include a full process mechanical, electrical, odor control, and appurtenant facility upgrades to provide flood protection, improved reliability and increase pumping capacity for 30 to 65 mgd. Pumping capacity will be limited to 40 mgd until the Phase II capacity improvements at the ESWPAF are completed.

The following sections summarize the major components of this planned upgrade, and Appendix C includes a Preliminary Basis of Design Report that details the design progression and basis for this upgrade. As previously described, the current alternative is to direct all flow from the Union Pump Station through the gravity system toward the East Street Pump Station, and increase its operational capacity to 65 mgd. By increasing pump capacity, space constraints became a driving criteria for pump selection and layout. The objective is to select both dry weather and wet weather pumps that operate within their preferred operating range (POR) while maintaining redundancy and even distribution of flow across all dry weather and storm events.

Through a number of iterations of pump selection and process mechanical layouts, it became apparent that the most efficient and operable solution was to construct a separate dry weather pump station adjacent to the existing East Street Operations building to allow for efficient pump sizing along with provisions for redundancy. The existing facility will be upgraded for wet weather pumping operations.

Implementation of this operational philosophy allows for the construction of the new dry weather pump station and electrical appurtenances while maintaining the current pump station in operation. The wet weather portion of the station already has redundancy so electrical and process mechanical upgrades could be staged to allow maintenance of flow throughout the facility upgrade.

All dry weather and wet weather flow will pass through the existing headworks prior to reaching the pump stations. The existing headworks facilities would be upgraded to hydraulically pass 65 mgd by adding a third mechanical screen.

Downstream of the headworks facilities the flow will either go to the new dry weather pump station or the existing pump station serving as a wet weather pump station. A diversion chamber will direct flow to one of the two pump stations.

The new dry weather pump station will be a submersible station with two duty pumps and one standby pump. The maximum dry weather flows will be met with two pumps in operation. One pump in operation will be able to convey the minimum dry weather flow without cycling. The maximum flow from the dry weather pump station will overlap with the minimum flow from the wet weather pump station to allow for a smooth transition.

The wet weather pump station will have four duty pumps and one standby pump. The maximum wet weather flows will be met with four pumps in operation.

Further detail regarding the developing of the influent flow profile, and pump selection philosophy is included in Appendix C.

The electrical and instrumentation and control (I&C) systems at the station have reached the end of their useful service lives. The systems will be replaced and moved to a room on the second floor. The room will be expanded to the south to provide sufficient space to house the new gear and provide flood protection.

New heating, ventilation, and air conditioning (HVAC) and centralized odor control facilities will be provided that include upgraded ventilation and a climate controlled room for major electrical systems and supervisory control and data acquisition (SCADA) equipment. The odor control system will be replaced with a granular activated carbon scrubber system located between the inlet works and operations building.

Details of the electrical, HVAC, and odor control system configuration are included in Appendix C.

5.5.3 Union Pump Station Intermediate Improvements

Intermediate-Term improvements at Union Pump Station include a full process mechanical, electrical, odor control, and appurtenant facility upgrades to provide flood protection, improve reliability, and increase pumping capacity from 15 mgd to 35 mgd. Pumping capacity will be limited to 15 mgd until the Phase II capacity improvements at the ESWPAF are completed.

The following sections summarize the major components of this planned upgrade, and Appendix D includes a Preliminary Basis of Design Report that details the design progression and basis for this upgrade.

An inlet grinder system will replace the existing screens to protect the pumps from stringy material and large objects. Two grinders would be installed (one in each channel) that would be able to handle the peak wet weather flow of 35 mgd.

Downstream of the grinders the flow enters a divided wet well. The existing pumps will be replaced with two dry weather and three wet weather pumps. The dry weather pumps will be able to pump the maximum dry weather flows with one duty and one standby pump. The dry weather pumps will draw from opposites sides of the divided wet well.

The wet weather pumps will be able to pump the maximum wet weather flow with two duty pumps and one standby pump. Two wet weather pumps will draw from one side of the divided wet well and the third wet weather pump will draw from the opposite side of the divided wet well. The maximum flow from one dry weather pump will overlap with the minimum flow from one wet weather pump to provide a smooth transition between the two systems.

Further detail regarding the developing of the influent flow profile and pump selection philosophy is included in Appendix D.

The electrical and I&C systems at the facility have reached the end of their useful service lives, and there is currently no odor control facility at the pump station. As part of the redundancy and reliability upgrade, new electrical and I&C systems will be installed and emergency power provisions will be included.

New HVAC and odor control facilities will be installed that include upgraded ventilation and a climate controlled room for major electrical systems and SCADA equipment. An activated carbon treatment system will be provided to manage odorous air at the station.

Details of the electrical, HVAC, and odor control system configuration is included in Appendix D.

The existing 24-inch force main and the existing utility bridge across Metro-North will be replaced in the same location.

5.5.4 Boulevard Pump Station Intermediate Improvements

Intermediate-Term improvements at the Boulevard Pump Station include a full process mechanical, electrical, odor control, and appurtenant facilities upgrades to provide flood protection, improve reliability, and increase pumping capacity from 30 mgd to 45 mgd. Pumping capacity will be limited to 30 mgd until the Phase II improvements at the ESWPAF are completed.

The following sections summarize the major components of this planned upgrade, and Appendix E includes a Preliminary Basis of Design Report that details the design progression and basis for this upgrade. Based on the objectives of the LTCP to eliminate CSO discharges for the 2-year, 6-hour storm event, modeling has shown that the capacity of the Boulevard Pump Station needs to be increased to 45 mgd to achieve that performance criteria. Due to the significant increase in flow at the East Street Pump Station, the total dynamic head that Boulevard Pump Station will have to overcome will be significantly higher requiring much larger wet weather pumps than are currently in use.

Through the alternatives analysis phase, it was determined that there was insufficient space at the Boulevard Pump Station to install adequate dry weather pumps with redundancy while maintaining sufficient wet weather pumping capacities in the existing station. Therefore, the existing station will be used for wet weather pumps only, and a separate dry weather pump station will be installed adjacent to the structure within the driveway area, similar to the East Street Pump Station.

Implementing this philosophy will allow the dry weather pump station to be constructed and tested while the existing station manages both dry and wet weather flows as it currently does. Once the dry weather station is active, then process upgrades to the wet weather pumps and electrical equipment can be staged while maintain both dry and wet weather pumping redundancies.

All dry weather and wet weather flow will pass through the existing headworks prior to reaching the pump stations. The existing headworks facilities would be upgraded to hydraulically pass 45 mgd by adding a third mechanical screen.

Downstream of the headworks facilities the flow will either go to the new dry weather pump station or the existing pump station serving as a wet weather pump station. A diversion chamber will direct flow to one of the two pump stations.

The new dry weather pump station will be a submersible station with two duty pumps and one standby pump. The maximum dry weather flows will be met with two pumps in operation. One pump in operation will be able to convey the minimum dry weather flow without cycling. The maximum flow from the dry weather pump station will overlap with the minimum flow from the wet weather pump station to allow for a smooth transition.

The wet weather pump station will have three duty pumps and one standby pump. The maximum wet weather flows will be met with three pumps in operation.

Further detail regarding the developing of the influent flow profile, and pump selection philosophy is included in Appendix E.

The electrical and I&C systems at the facility have reached the end of their useful service lives and will be replaced.

New HVAC and centralized odor control facilities will be provided that include upgraded ventilation and a climate controlled room for major electrical systems and SCADA equipment. The odor control system will be replaced with a granular activated carbon scrubber system located on the roof of the existing pump station.

Details of the electrical, HVAC, and odor control system configuration are included in Appendix E.

5.5.5 Boulevard Relief Sewer

A hydraulic bottleneck occurs in the Boulevard Trunk Sewer at REG 024 when the 84 x 69-inch oval sewer flows into a 48-inch circular sewer. This bottleneck limits the amount of flow to the Boulevard Pump Station and creates overflows at CSO outfall 024. With the increased capacity of 45 mgd at the Boulevard Pump Station, a relief sewer can be constructed to decrease CSO volume and increase flow to the Boulevard Pump Station. The sewer will consist of 600 feet of 48-inch pipe. The sewer location is shown below in Figure 5-12.

Figure 5-12. Boulevard Relief Sewer

Proposed location of the 600' 48" relief sewer in the Boulevard Sewershed

Long-Term CSO Control Plan

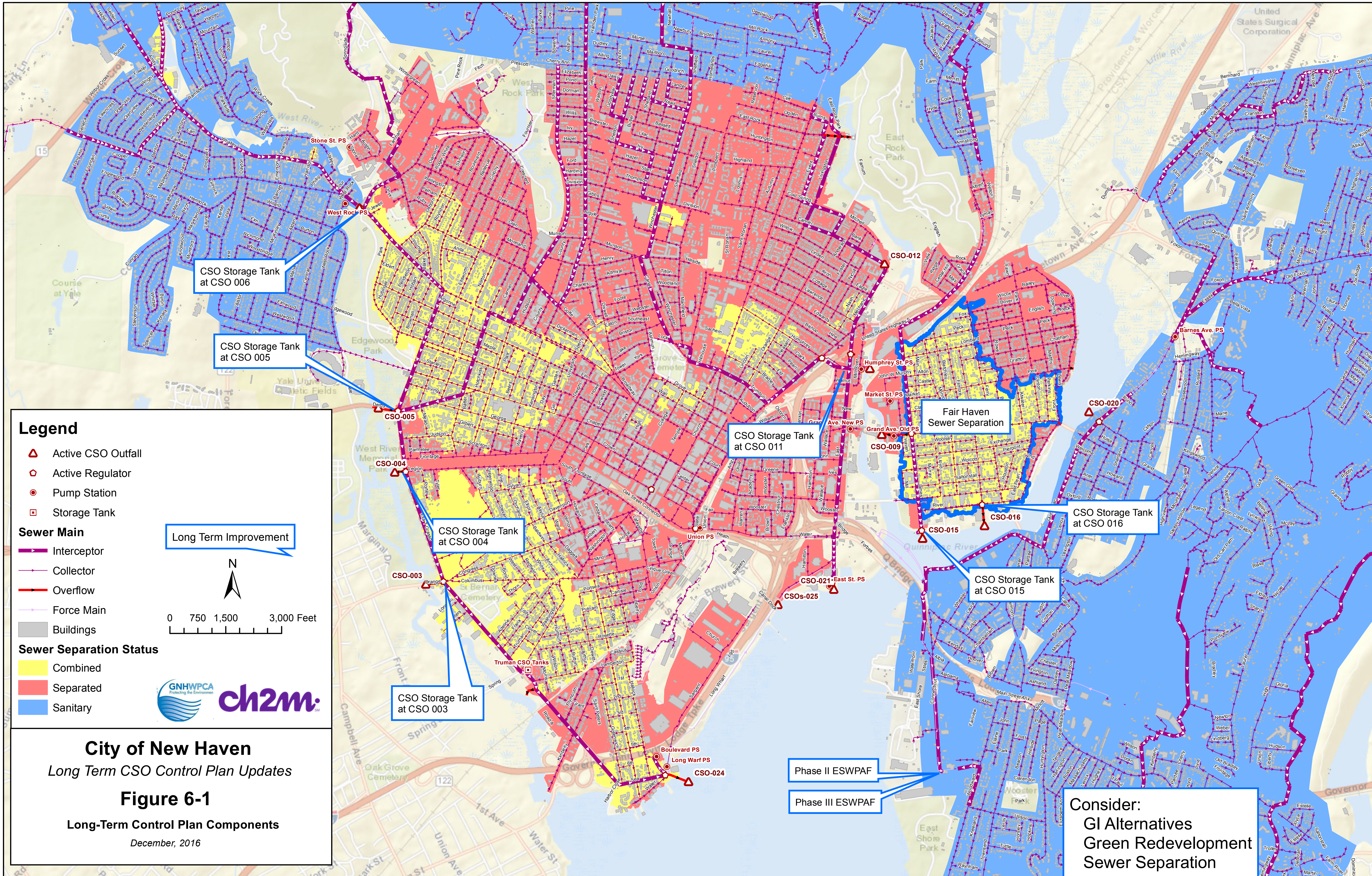
6.1 Basis of the Long-Term Control Plan

The Long-Term improvements include system upgrades which are expected to be initiated in 2024 and be completed by 2040. This will be the final of the three milestones to remove or control CSO discharge from all CSO outfalls resulting from wet weather events up to and including the 2-year, 6-hour design storm for the service area. The focus of these improvements is the upgrade of the ESWPAF to increase the treatment capacity to 160 mgd, sewer separation in the Fair Haven area, and the construction of CSO Storage Tanks. Among the controls listed in this report, GNHWPCA will continue to monitor the progress of previous controls to determine the extent of the level of control required to capture the remaining CSO volume. Green infrastructure alternatives, green redevelopment projects and additional sewer separation are among the few alternatives that will be examined to tailor CSO elimination while providing the greatest benefits for the City of New Haven.

6.2 Components of the Long-Term Control Plan

The controls included in the LTCP will provide the final improvements to meet the goal of the Consent Order and will allow the three major pump stations to operate at full capacity with the wet weather improvements made to the ESWPAF. The controls included in the LTCP are listed below and shown on Figure 6-1.

- **Phase II and III East Shore WPAF Wet Weather Capacity Improvements –** Design and construction of wet weather improvements to provide flood protection, improve reliability and upgrade treatment capacity up to 160 mgd. These improvements include upgrades to Headworks, Preliminary Treatment, Primary Treatment, Incineration, Nitrogen Removal (IFAS), Disinfection, Odor Control, and Power Distribution to new facilities in order to maximize treatment of wet weather flows at the East Shore WPAF.
- **Fair Haven Sewer Separation Project –** The design and construction of sewer separation of 365 acres of sewershed in Fair Haven in order to reduce CSO frequency, duration and volume at CSO outfalls 009, 015 and 016.
- **CSO Storage Tanks –** The design and construction of CSO storage tanks totaling 5.7 MG at the following CSO outfalls: 003 (0.1 MG), 004 (0.7 MG), 005 (1.7 MG), 006 (1.3 MG), 011 (1.3 MG), 015 (0.4 MG), and 016 (0.2 MG) in order to capture CSOs resulting from wet weather events up to and including the 2-year, 6-hour design storm.



City of New Haven

Long Term CSO Control Plan Updates

Figure 6-1

Long-Term Control Plan Components

December, 2016

6.3 LTCP Performance

The LTCP model scenario was run for the 2-year, 6-hour design storm as well as the Typical Year. The control plan effectively reduced CSO volumes, as shown in Figures 6-3 and 6-4, and Tables 6-1 and 6-2 from 2016 conditions. Under the ITCP, the system discharges 9.4 MG of CSO during the 2-year, 6-hour design storm and 12.8 MG of CSO over 8 discrete CSO events (45 systemwide total events) during the Typical Year. Completion of the LTCP projects reduces CSO volume by 100 percent during the design storm to 0.0 MG and 100 percent during the Typical Year to 0.0 MG with 0 events.

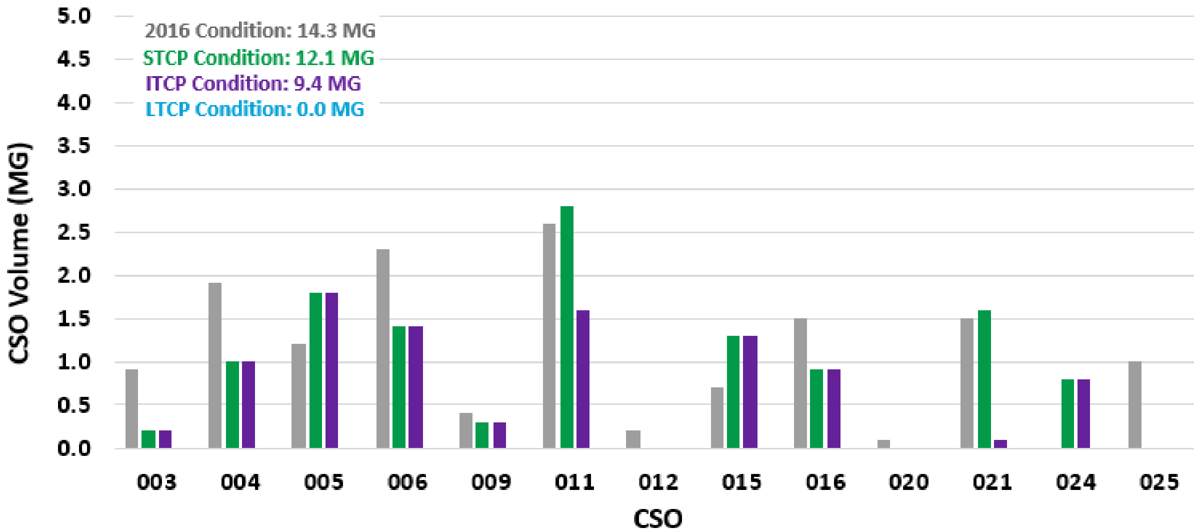


Figure 6-3. System Performance under the LTCP during the Design Storm
Comparison of system performance between 2016 Conditions, the STCP, the ITCP and the LTCP during the 2-year, 6-hour design storm

Table 6-1. System Performance under the LTCP during the Design Storm
Overflow volume from all the active CSOs

Receiving Water	CSO Outfall	CSO Volume (MG) 2016	STCP	ITCP	LTCP
West River	003	0.9	0.2	0.2	0.0
	004	1.9	1.0	1.0	0.0
	005	1.2	1.8	1.8	0.0
	006	2.3	1.4	1.4	0.0
	Subtotal	**6.3**	**4.4**	**4.4**	**0.0**
Mill River	009	0.4	0.3	0.3	0.0
	011	2.6	2.8	1.6	0.0
	012	0.2	Closed	Closed	0.0
	Subtotal	**3.2**	**3.1**	**1.9**	**0.0**
Quinnipiac River	015	0.7	1.3	1.3	0.0
	016	1.5	0.9	0.9	0.0
	020	0.1	Closed	Closed	0.0
	Subtotal	**2.3**	**2.2**	**2.2**	**0.0**
New Haven Harbor	021	1.5	1.6	0.1	0.0
	024	0.0	0.8	0.8	0.0

Table 6-1. System Performance under the LTCP during the Design Storm

Overflow volume from all the active CSOs

Receiving Water	CSO Outfall	CSO Volume (MG) 2016	STCP	ITCP	LTCP
	025	1.0	0.0	0.0	0.0
	Subtotal	**2.5**	**2.4**	**0.9**	**0.0**
	Systemwide Total	**14.3**	**12.1**	**9.4**	**0.0**

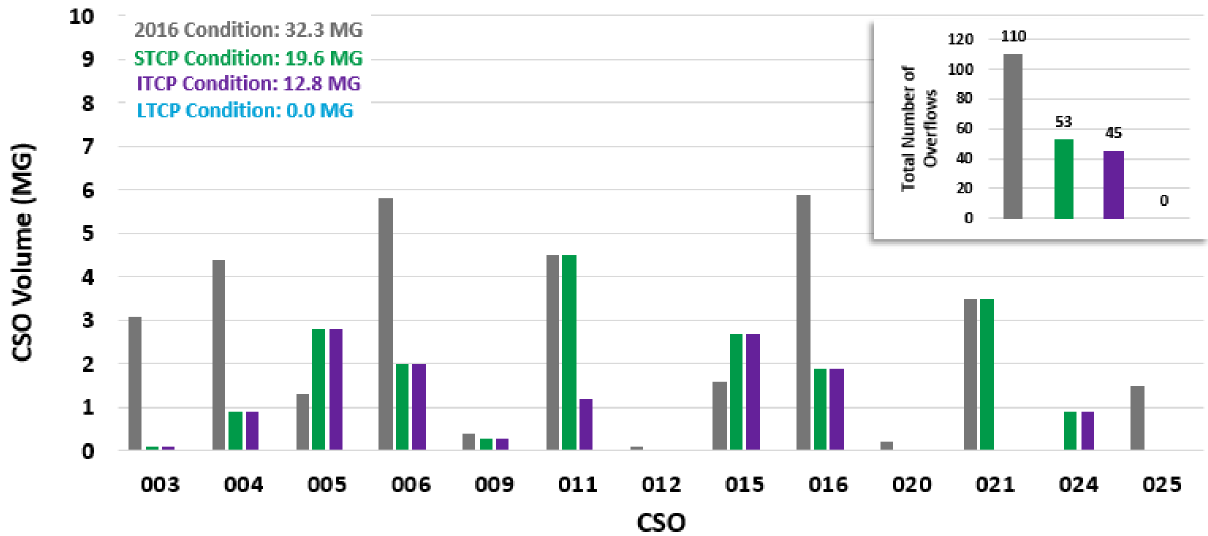


Figure 6-4. System Performance under the LTCP during the Typical Year

Comparison of system performance between 2016 Conditions, the STCP, the ITCP and the LTCP during the Typical Year

Table 6-2. System Performance under the LTCP during the Typical Year

Overflow volume from all the active CSOs

Receiving Water	CSO Outfall	2016 CSO (MG)	2016 Events	STCP CSO (MG)	STCP Events	ITCP CSO (MG)	ITCP Events	LTCP CSO (MG)	LTCP Events
West River	003	3.1	15	0.1	2	0.1	2	0.0	0
	004	4.4	19	0.9	5	0.9	5	0.0	0
	005	1.3	6	2.8	6	2.8	6	0.0	0
	006	5.8	9	2.0	6	2.0	6	0.0	0
	Subtotal	**14.6**	**49**	**5.8**	**19**	**5.8**	**19**	**0.0**	**0**
Mill River	009	0.4	3	0.3	3	0.3	3	0.0	0
	011	4.5	6	4.5	6	1.2	4	0.0	0
	012	0.1	2	Closed	Closed	Closed	Closed	Closed	Closed
	Subtotal	**5.0**	**11**	**4.8**	**9**	**1.5**	**7**	**0.0**	**0**
Quinnipiac River	015	1.6	9	2.7	8	2.7	8	0.0	0
	016	5.9	27	1.9	8	1.9	8	0.0	0
	020	0.2	5	Closed	Closed	Closed	Closed	Closed	Closed
	Subtotal	**7.7**	**41**	**4.6**	**16**	**4.6**	**16**	**0.0**	**0**

Table 6-2. System Performance under the LTCP during the Typical Year
Overflow volume from all the active CSOs

Receiving Water	CSO Outfall	2016		STCP		ITCP		LTCP	
		CSO (MG)	Events	CSO (MG)	Events	CSO (MG)	Events	CSO (MG)	Events
New Haven Harbor	021	3.5	6	3.5	6	0.0	0	0.0	0
	024	0.0	0	0.9	3	0.9	3	0.0	0
	025	1.5	3	0.0	0	0.0	0	0.0	0
	Subtotal	**5.0**	**9**	**4.4**	**9**	**0.9**	**3**	**0.0**	**0**
Systemwide Total		**32.3**	**110**	**19.6**	**53**	**12.8**	**45**	**0.0**	**0**

Under the LTCP, the maximum potential total flow to the East Shore WPAF is 160 during the 2-year, 6-hour design storm. The system flow diagram is shown below in Figure 6-5.

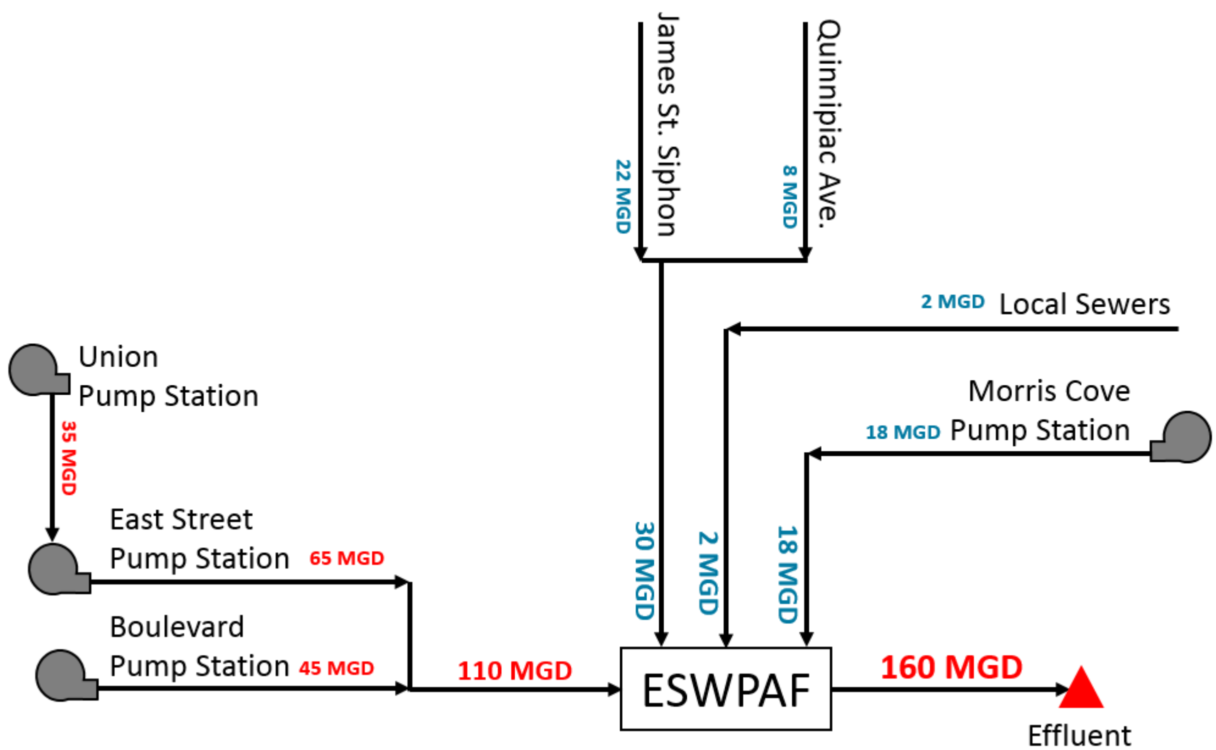


Figure 6-5. LTCP Flow Diagram
Potential flows received by the East Shore WPAF under the LTCP during the 2-year 6-hour design storm

6.4 East Shore Water Pollution Abatement Facility Upgrades

The 2011 LTCP Update presents a plan to complete required upgrades to the East Shore WPAF. This Long Term Control Plan Update specifies that flows up to 160 mgd will be conveyed to the plant to remove or control CSO discharges from all CSO outfalls resulting from wet weather events up to and including the 2-year, 6-hour design storm for the service area. The overall philosophy of improvements required at the East Shore WPAF has not changed since the 2011 LTCP Update was approved by DEEP.

Phase I of the upgrades to the East Shore WPAF are scheduled to be complete in 2017 at a project cost of $60 million. Phase I upgrades focused on infrastructure improvements to support higher wet weather flows to be conveyed to the plant. The upgrades focused on odor control, solids processing facilities, nitrogen reduction upgrades, secondary treatment and electrical upgrades.

With the completion of the Phase I upgrade slight modifications were made to site planning conducted in the 2011 LTCP Update. Sections 6.6 and 6.7 of this report provide an update on the existing site plan and briefly summarize the process improvements as they are described in the 2011 LTCP Update Plan. No changes to this approved plan are being proposed. The next Long Term Control Plan Update scheduled to be completed in 2022, will focus on detailing the Phase II East Shore WPAF improvements to treat higher flows from the East Street, Union and Boulevard Pump Station upgrades completed as part of the Intermediate-Term Improvements.

6.5 Phase I Wet Weather Capacity Upgrades

The Wet Weather Capacity and Nitrogen Removal Phase I project consists of a number of upgrades to the East Shore WPAF, including biological nutrient removal (BNR) improvements (second anoxic zone and supplemental carbon), rehabilitation of the secondary clarifiers, odor control improvements, construction/retrofit of a new sludge handling facility, and extensive electrical system improvements.

The BNR upgrades concentrated on the following areas: biological reactor basins (BRB) modifications, secondary clarifier rehabilitation, and return & waste activated sludge pump and valve replacement. BRB tank renovations consisted of adding a second anoxic zone to further reduce effluent total nitrogen loads. A new methanol storage and feed system provides a supplemental carbon source for BNR. The second anoxic zone was created by constructing two concrete baffle walls across the last third of the existing aerobic zone in each of the four trains. New submersible mixers were installed in each second anoxic zone. The existing ceramic diffuser grid system was completely replaced with a fine bubble membrane diffuser grid system and reconfigured to meet process requirements. A new 48" intake pipe was also installed to convey nitrified mixed liquor from the third aeration zone to the nitrogen rich recycle (NRCY) pump station. Additionally, GNHWPCA conducted a site wide energy audit at the East Shore WPAF during the design phase. The results of the audit showed a substantial energy efficiency increase based largely on the designed BNR improvements.

Each of the plant's eight Secondary Clarifiers mechanisms were replaced entirely with new equipment including drive units, corner sweep mechanisms, scum skimmers and walkway bridges. All tankage was retrofitted with new fiberglass weirs, scum baffles, density current baffles and instrumentation. The existing grout topping was to be removed and replaced, however an inspection and evaluation was performed by GNHWPCA resulting in only spot repairs being made to the topping slabs. This reduction in scope provided a substantial cost savings allowing this funding to be invested in other improvements. Additionally, return & waste activated sludge pumps (RAS & WAS) and associated isolation valves were replaced in a crowded pump station as part of the project (20 pumps total).

The existing plant odor control process consisted of various satellite scrubber units scattered around the East Shore WPAF. This project eliminated these satellite units and provided one centralized odor control facility. The Phase I construction of this facility consists of 3 packed tower scrubbers capable of each treating 57,000 CFM of odorous air. Blowers were installed in a temperature controlled facility to reduce noise and improve the lifespan of the blowers. The facility was designed with room for 1 additional packed tower scrubber to be installed during Phase II construction to treat future odor loads.

The existing sludge handling facility consisted of one sludge storage tank, one gravity thickener, two abandoned digesters, and an associated pump gallery. This area was retrofitted and expanded into a sludge handling facility that included a new 60' diameter concrete storage tank with a capacity of over 550,000 gallons, one new gravity thickener retrofitted from the existing sludge storage tank, and one dual use sludge storage tank/gravity thickener retrofitted from the existing gravity thickener. Both sludge storage tanks utilize hydraulic mixing systems. GNHWPCA implemented a detailed construction sequence of work, which prevented the many associated processes from becoming significantly impacted during construction activities.

The existing electrical infrastructure at the East Shore WPAF, which had become outdated and presented a serious risk to maintaining effective treatment, was replaced during the Phase I project. The new equipment replaced aging 1970's era main electrical gear located 1,000's of feet away, which were installed in a basement substation subject to flooding. The electrical upgrades and replacements in this project included the construction of a new electrical building constructed to house state-of-the-art 13.8KW entrance and switchgear 3 feet above the 100 year flood plain.

6.6 East Shore WPAF Site Plan

The East Shore WPAF site covers approximately 23 acres and is located at 345 East Shore Parkway in New Haven, about 1 mile south of Interstate 95 and half a mile west from Fort Wooster Park. GNHWPCA owns all property designated for current and future facilities.

6.6.1 Existing Topography and Facility Layout

During Phase I detailed design of the site features, modifications in structure location were required due to operability and construction phasing considerations. The site plan identifying the current planned facility locations for the wet weather improvements at the East Shore WPAF are shown in Figure 6-6. This site plan shows the modifications to the locations of the preliminary treatment building, odor control building, supplemental carbon building, and other appurtenance structures. Facilities shown in yellow are currently under construction as part of Phase I scheduled for completion in 2017, and those in blue are future facilities to be constructed as part of Phases II and III.

6.7 East Shore WPAF Process Flow

The process flow diagram shown in Figure 6-7 illustrates the process modifications at the East Shore WPAF necessary to support both the nitrogen reduction and wet weather improvements. The future wet weather improvements to be constructed as part of Phases II and III to accommodate the increased flow being pumped to the plant are shown in dark black. Existing infrastructure including those facilities being built as part of the Phase I project are screened black. The overall philosophy of improvements required at the East Shore WPAF has not changed since approval of the 2011 LTCP Update.

The flow diagram is divided by unit process.

6.7.1 Plant Influent

Raw influent wastewater flow enters the plant through a gravity sewer and a 48-inch force main. The gravity sewer enters the existing head works building where it is coarse screened and flows by gravity to the raw wastewater existing pump station in the main building. These coarse screens were upgraded in June 2016 under a separate construction contract and will remain an integral component of the gravity system inlet works treatment system. The existing main building pump station pumps the gravity flow received at the plant to the preliminary treatment building which is to be constructed as part of Phase II. The 48-inch force main flows will discharge directly to the preliminary treatment building. Once the flow is lifted to the inlet channel of the preliminary treatment building, it flows by gravity through the remaining treatment processes. The raw wastewater flow combines with several return streams from the plant site as well as the delivery of septage.

6.7.2 Preliminary Treatment

The preliminary treatment unit process to be constructed as part of Phase II consist of fine screening, grit removal, and truck unloading. All flow to the plant will be metered and then screened via the fine screens and will receive grit removal. The Long-Term plant influent flow conditions, less recycles, are summarized in Table 6-3.

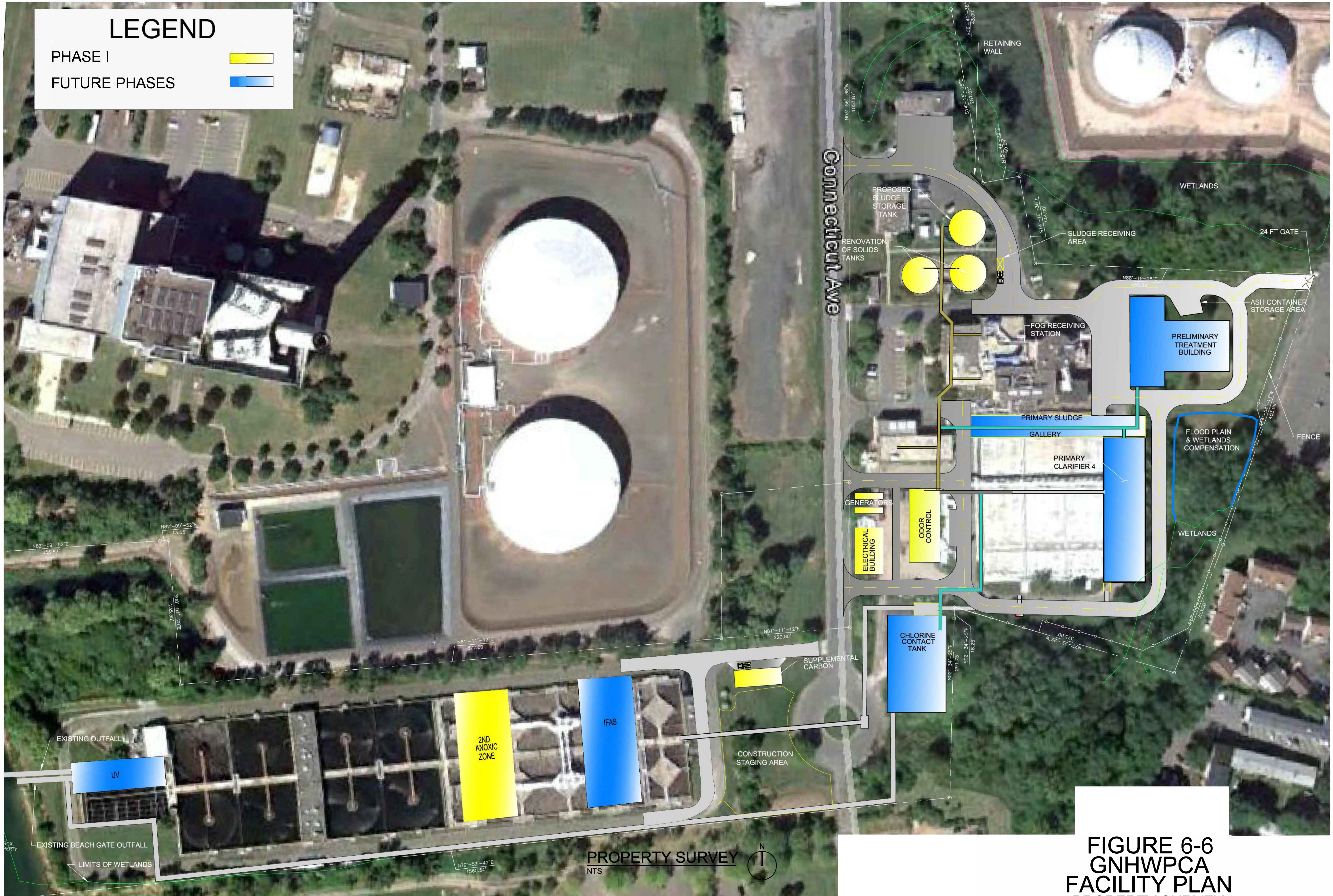


FIGURE 6-6
GNHWPCA
FACILITY PLAN
PROPERTY SURVEY

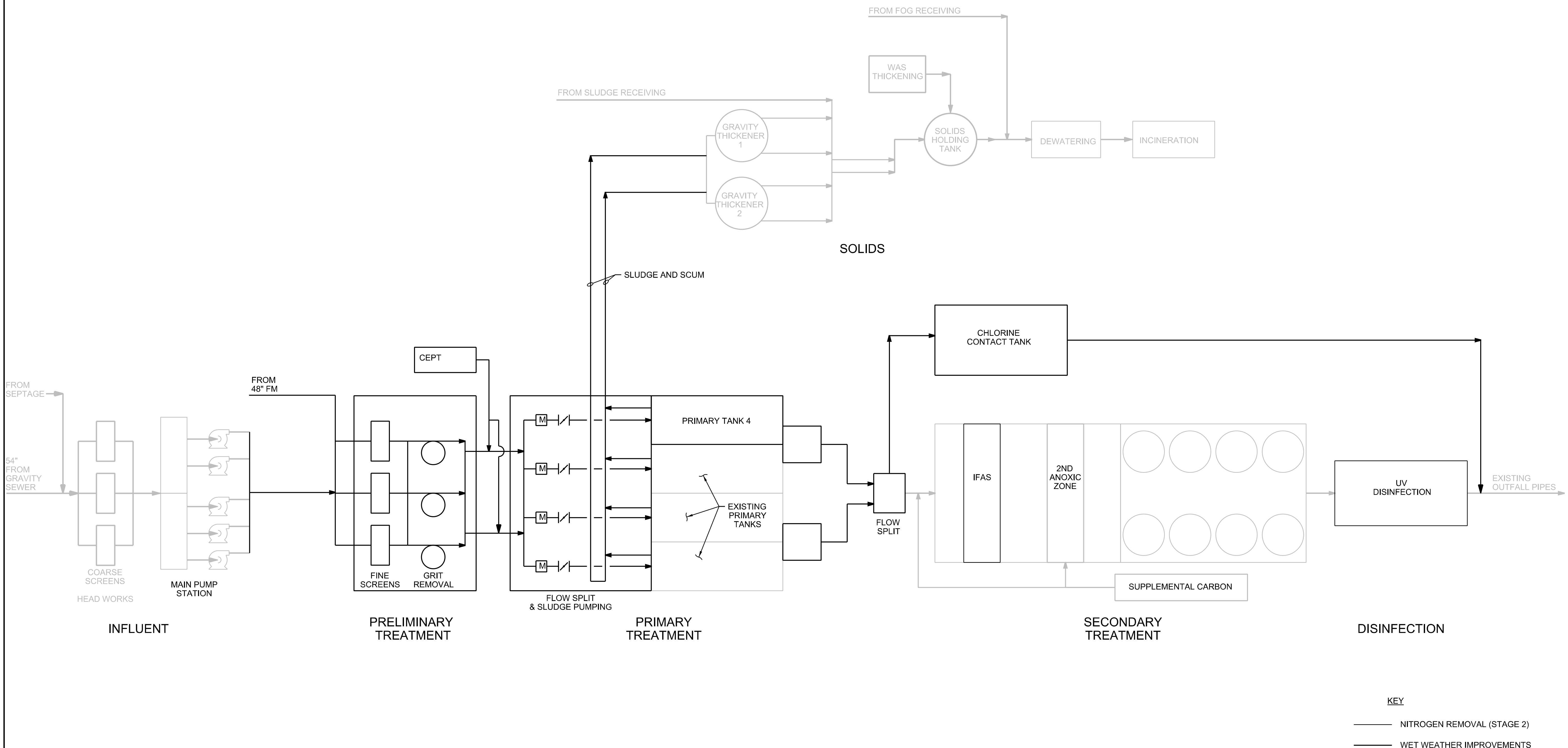


FIGURE 6-7
GNHWPCA
FACILITY PLAN
EAST SHORE WPAF PROCESS FLOW DIAGRAM

CH2MHILL

386448

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Table 6-3. Long-Term Plant Influent Flow

Flow Condition	Flow
Dry Weather Annual Average	30 mgd
Dry Weather Max Month	45 mgd
Dry Weather Peak Hydraulic (Permit)	60 mgd
Wet Weather Peak Hydraulic	160 mgd

6.7.3 Primary Treatment

The primary treatment unit process splits the flow equally to the three existing and fourth proposed (to be constructed as part of Phase II) primary clarifiers through the use of flowmeters and control valves. Settled solids are collected and pumped to the solids handling unit process upgraded during Phase I construction activities. During wet weather conditions, defined as flows above 60 mgd, a chemical coagulant will be added to the primary treatment influent to promote the settling and collection of suspended solids. The primary treatment effluent is split into dry and wet weather flows. All flows up to and including 60 mgd as measured by a Parshall Flume (to be constructed as part of Phase II) will be conveyed to the secondary treatment unit process. Flows above 60 mgd are diverted to wet weather treatment train.

6.7.4 Secondary Treatment

The secondary treatment unit process consists of biological treatment for the dry weather flow. Nitrogen reduction is accomplished by this unit process. Secondary clarifier replacement, along with return activated sludge (RAS) pump replacement and biological reactor basin (BRB) improvements were constructed as part of the Phase I construction project further improving the secondary treatment efficiency.

During wet weather, the flow to the aeration tanks and secondary clarifiers is limited to 60 mgd. At 42 mgd, slide gates on the diversion channel running longitudinally down the center of the aeration tanks will be modulated so that flow from 42 mgd to 60 mgd will be partially or fully diverted from the anoxic zone of BRB basins and will be step fed into aeration zones 2 & 3 to protect mixed liquor inventory during wet weather conditions.

6.7.5 Disinfection

The disinfection unit process will consist of both dry weather and wet weather disinfection. Future dry weather disinfection is by ultraviolet (UV) treatment and wet weather disinfection is by chlorination. The disinfection unit processes are separate and flows are not combined after disinfection. The dry and wet weather bypass disinfection process improvements will be included in Phase 2 of construction.

Cost Estimate and Implementation Schedule

This recommended plan was developed based on the alternatives analysis and evaluation presented in Sections 1 through 6 of this CSO LTCP Update and the requirements of the Conditions Consent Order. The analysis relied on CSO characteristics generated by the 2016 updated Hydraulic Model which incorporated CSO reduction projects completed through the end of 2015 and the $60 million Phase I Wet Weather Capacity Improvements and Nitrogen Reduction Project (CWF 2010-01) at the East Shore WPAF, which began in 2014 and is scheduled to be completed in 2017.

The goal of the CSO LTCP is to provide for measures necessary to remove or control CSO discharges from all CSO outfalls resulting from wet weather events up to and including the 2-year, 6-hour design storm for the service area by 2040. The recommended plan, costs and implementation schedule are discussed in this section.

7.1 Recommended Long-Term Control Plan Components

Figure 7-1 illustrates the components of the recommended plan. The components of the plan are listed by implementation phase to follow the timeline described in the Consent Order. These phases include:

- Short-Term Improvements
- Intermediate-Term Improvements
- Long-Term Improvements

Below are brief descriptions of the plan components by phase.

Short-Term Improvements

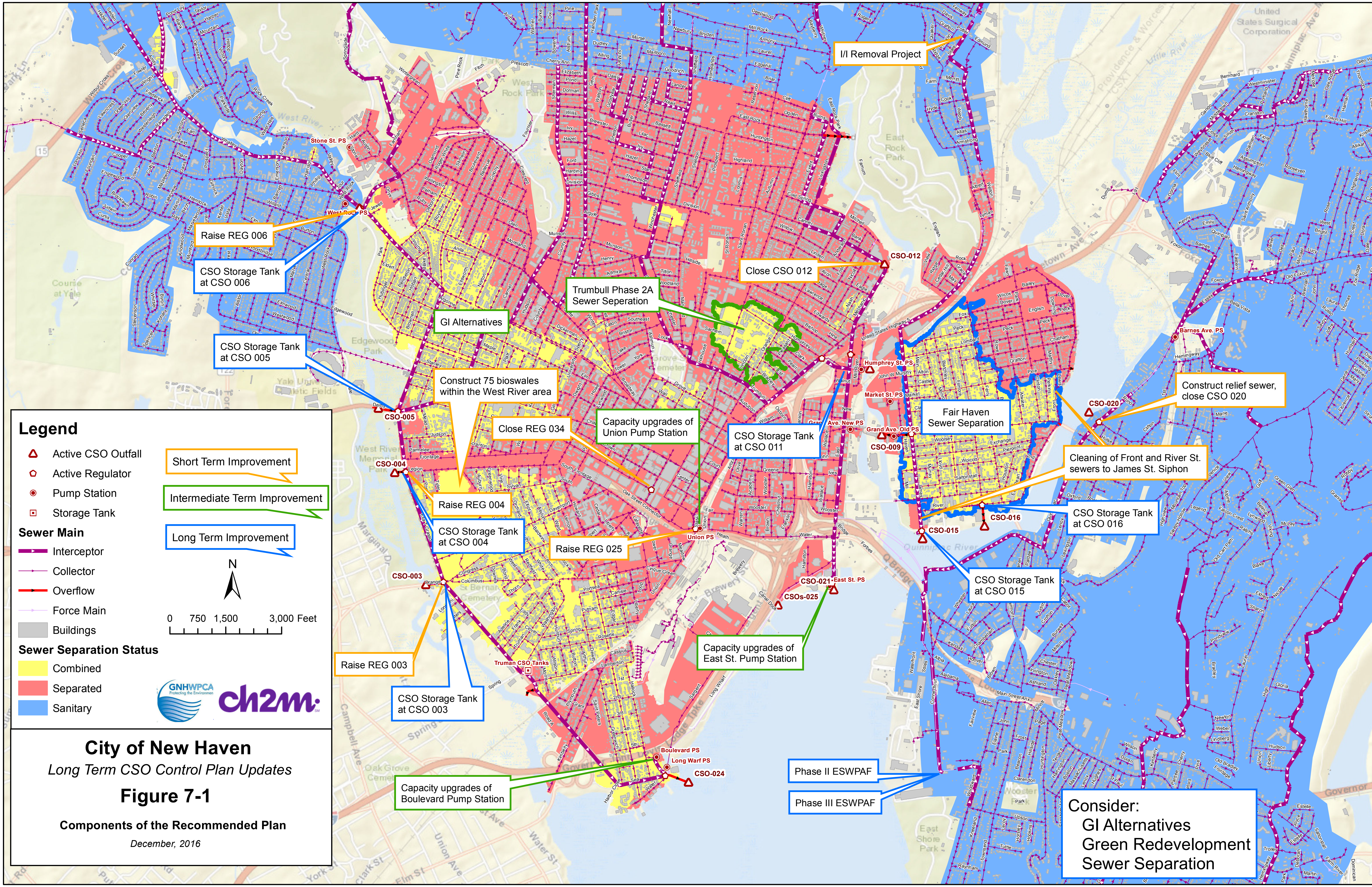
- **Regulators 012 and 020 Relief Sewers (CWF 2016-02) –** The design and construction of individual relief sewer segments and regulator improvements to reduce CSO frequency, duration and volume at CSO outfalls 012 and 020.
- **West River CSO Improvements (CWF 2016-03) –** The design and construction of improvements and modifications to Regulators 003, 004 and 006 along the Boulevard Trunk Sewer to reduce CSO discharges to the West River.
- **Regulator 034 Regulator Improvements (CWF 2016-05) –** The design and construction of regulator improvements to reduce CSO frequency, duration and volume at CSO regulator 034 and CSO outfall 025.
- **Green Infrastructure Improvements (CWF 2016-07 and CWF 2009-04) –** The design and construction of approximately 75 bioswales along City streets within combined sewer areas in the West River watershed to reduce the CSO frequency, duration and volume to the West River.
- **Cleaning of Front and River Street Sewers –** The inspection and cleaning of sewers along Front and River Street to the Jones Street Siphon to increase conveyance and capacity upstream of Regulators 015 and 016. This project was completed in 2016.
- **Infiltration/Inflow Removal Project –** The design and construction of sewer and manhole rehabilitation to remove inflow and infiltration in the State Street sewershed in Hamden upstream of Regulators 009 and 015. This project was also completed in 2016.

Intermediate-Term Improvements

- **Capacity Upgrade of East Street Pump Station –** The design and construction of upgrades to the East Street Pump Station to provide flood protection, improve reliability and increase pumping capacity from 30 to 65 mgd.
- **Yale Campus Trumbull Street Area Phase 2A Sewer Separation (CWF 2009-04) –** The construction of a combined sewer separation project that proposes to install new separate storm drains, and to reuse the existing combined sewer as a sanitary sewer in order to reduce CSO frequency, duration and volume at CSO outfall 011. The project consists of approximately 7,125 linear feet of storm piping ranging in diameter from 15 to 42 inches and a green infrastructure component that includes the construction of several bioswales. Design has been completed and utility relocation is underway.
- **Capacity Upgrade of Union Pump Station –** The design and construction of upgrades to the Union Pump Station and force main to provide flood protection, improve reliability and maintain pumping capacity to 35 mgd. Pumping capacity will be limited to 15 mgd until the Phase II ESWPAF Improvements are complete.
- **Capacity Upgrade of Boulevard Pump Station –** The design and construction upgrades to Boulevard Pump Station to provide flood protection, improve reliability and increase pumping capacity to 45 mgd. Pumping capacity will be limited to 30 mgd until the Phase II ESWPAF Improvements are complete.

Long-Term Improvements

- **Phase II and III East Shore WPAF Wet Weather Capacity Improvements –** Design and construction of wet weather improvements to provide flood protection, improve reliability and upgrade treatment capacity to 160 mgd. These improvements include upgrades to Headworks, Preliminary Treatment, Primary Treatment, Incineration, Nitrogen Removal (IFAS), Disinfection, Odor Control, and Power Distribution to new facilities in order to maximize treatment of wet weather flows at the East Shore WPAF.
- **Fair Haven Sewer Separation Project –** The design and construction of sewer separation of 365 acres of sewershed in Fair Haven in order to reduce CSO frequency, duration and volume at CSO outfalls 009, 015 and 016.
- **CSO Storage Tanks –** The design and construction of CSO storage tanks totaling 5.7 MG at the following CSO outfalls: 003 (0.1 MG), 004 (0.7 MG), 005 (1.7 MG), 006 (1.3 MG), 011 (1.3 MG), 015 (0.4 MG), and 016 (0.2 MG) in order to capture CSOs resulting from wet weather events up to and including the 2-year, 6-hour design storm.



City of New Haven

Long Term CSO Control Plan Updates

Figure 7-1

Components of the Recommended Plan

December, 2016

7.2 Long-Term Control Plan Cost Estimate

Cost estimates for the components of the recommended plan were generated based on the level of detail known at the time this report was prepared. A summary of the costs by component are summarized in Table 7-1.

The construction cost estimates for the Short Term Improvements were developed by design engineers working with the GNHWPCA. Design of the Short Term Improvements Projects are between 60 and 90 percent complete. A 20 percent Engineering and Administration allowance was included to arrive at total project costs. Costs for the cleaning of Front and River Street sewers and the I/I removal project in Hamden are not included since these projects were completed in 2016.

The construction cost estimates for the Intermediate and Long Term Improvement developed by CH2M are considered to be a Class 4, with an accuracy of between +50 and -30 percent. Contingencies ranging from 20 to 35 percent were applied based on the amount of planning and design conducted to date. A 20 percent Engineering and Administration allowance was included to arrive at total project costs. For the CSO storage tank estimates, an additional allowance has been included to cover potential land acquisition costs, if required. All construction and total project cost estimates are expressed in 2016 dollars.

Table 7-1 tabulates the construction cost and total project cost estimates for each plan component. A breakdown of the costs by component are detailed in Appendix F. The cost estimates in the appendix represent a detailed breakdown of project components commensurate with the level of design completion to date.

Table 7-1. Cost Estimate Summary

Component	Construction Cost Estimate	Engineering and Administration Allowance	Total Project Cost Estimate
SHORT-TERM IMPROVEMENTS			
Regulators 012 and 020 Relief Sewers	$4,500,000	$900,000	$5,400,000
West River CSO Improvements	$2,100,000	$400,000	$2,500,000
Regulator 034 Relief Sewer	$830,000	$170,000	$1,000,000
Green Infrastructure Improvements	$1,250,000	$250,000	$1,500,000
	SUBTOTAL – SHORT-TERM IMPROVEMENTS		**$10,400,000**
INTERMEDIATE-TERM IMPROVEMENTS			
Capacity Upgrade of East Street Pump Station	$28,970,000	$5,895,000	$34,865,000
Yale Campus Trumbull Street Phase 2A Sewer Separation	$9,960,000	$1,990,000	$11,950,000
Capacity Upgrade of Union Pump Station	$14,130,000	$2,830,000	$16,960,000
Capacity Upgrade of Boulevard Pump Station	$28,645,000	$5,730,000	$34,375,000
2022 LTCP Update		$500,000	$500,000
	SUBTOTAL – INTERMEDIATE-TERM IMPROVEMENTS		**$98,700,000**

Table 7-1. Cost Estimate Summary

Component	Construction Cost Estimate	Engineering and Administration Allowance	Total Project Cost Estimate
LONG-TERM IMPROVEMENTS			
Phase II East Shore WPAF Wet Weather Capacity Improvements			
Preliminary Treatment and Odor Control	$45,330,000	$9,100,000	$54,400,000
Primary Clarifiers with CEPT	$30,280,000	$6,100,000	$36,400,000
Head Works with CEPT & Septage	$9,680,000	$2,000,000	$11,700,000
Disinfection	$21,675,000	$4,400,000	$26,100,000
Power Distribution	$4,650,000	$950,000	$5,579,000
2028 LTCP Update		$500,000	$500,000
Phase III East Shore WPAF Wet Weather Capacity Improvements			
Incineration	$5,000,000	$1,000,000	$6,000,000
Nitrogen Removal (IFAS)	$23,825,000	$4,765,000	$28,590,000
2034 LTCP Update		$500,000	$500,000
Fair Haven Sewer Separation	$78,653,000	$15,731,000	$94,385,000
CSO Storage Tanks			
CSO 003 Storage Tank (0.1 MG)	$1,995,000	$400,000	$2,395,000
CSO 004 Storage Tank (0.7 MG)	$6,172,000	$1,234,000	$7,406,000
CSO 005 Storage Tank (1.7 MG)	$13,134,000	$2,627,000	$15,761,000
CSO 006 Storage Tank (1.3 MG)	$10,976,000	$2,195,000	$13,171,000
CSO 011 Storage Tank (1.3 MG)	$10,558,000	$2,112,000	$12,670,000
CSO 015 Storage Tank (0.4 MG)	$4,014,000	$803,000	$4,817,000
CSO 016 Storage Tank (0.2 MG)	$2,970,000	$594,000	$3,564,000
		SUBTOTAL – LONG-TERM IMPROVEMENTS	$**323,900,000**
		TOTAL PROGRAM COSTS	$**433,000,000**

Figure 7-2 also includes the project cost estimates as well as the anticipated grant percentage and amount from the Clean Water Fund, the City of New Haven's 40 percent share of the CWF loan and the SNHWPCA's 60 percent share of the CWF loan.

7.3 LTCP Implementation Schedule

Figure 7-2 presents the implementation schedule for all remaining CSO LTCP improvements.

Design of the Short-Term improvements began in 2016. Construction of the Short Term Improvement Projects are expected to begin in 2017 and be complete by 2018. These improvements were identified in the 2015 Hydraulic Model Update Report and progressed quickly as they provide substantial CSO reductions as described in this report.

The Intermediate-Term Improvements will upgrade the major pump stations at East Street, Union and Boulevard to prepare for increased conveyance to the East Shore WPAF, and implement sewer separation across approximately 50 acres of sewershed in the Yale/Trumbull Phase 2A area. Intermediate-Term improvements are expected to be initiated in 2018 and complete by 2028.

The Long Term Improvements will upgrade the East Shore WPAF to provide treatment capacity for up to 160 mgd, utilize capacity upgrades at East Street, Union and Boulevard Pump Stations to convey flow to the treatment plant and finally provide remaining required sewer separation and CSO storage tank construction to eliminate CSOs for a 2-year, 6-hour storm by 2040. The Long-Term improvements are expected to be initiated in 2024 and be completed by 2040.

As the CSO LTCP is an evolving program being implemented over the course of a number of years, each future CSO LTCP update (scheduled for 2022, 2028 and 2034) will evaluate the effectiveness of components of the plan that have already been implemented in terms of CSO reduction. Each future CSO LTCP will also re-evaluate the components of the recommended plan to incorporate lessons learned and new technologies that may become available in order to achieve the goal. The goal of the CSO Long Term Control Plan is to provide for measures necessary to remove or control CSO discharges from all CSO outfalls resulting from wet weather events up to and including the 2-year, 6-hour design storm for the service area by 2040.

7.4 Task 3 – Screening Level Analysis of Long Term CSO Elimination

CH2M HILL will utilize the CT DOT hyetograph for the 25 year 6 24-hour design storm to analyze a Long Term CSO Elimination Alternative. This alternative will develop the capital cost of improvements to eliminate CSOs during the 25 year 6-hour design storm. Land constraints and constructability limitations of each component of the alternative will be identified. The following components may be screened in this alternative:

- Sewer separation of all combined sewer areas
  - Green infrastructure alternatives
  - Private inflow removal alternatives
- Complete I/I Reduction Programs in Hamden, East Haven and Woodbridge
  - Private inflow removal alternatives
- Relief sewer construction to increase conveyance to major pump stations and the ESWPAF
- Cleaning and lining of all large diameter sewers
- Major Pump Station Upgrades (Boulevard, East Street and Union) to increase conveyance to the ESWPAF
  - Pumping capacity
- Minor Pump Station Upgrades of up to 27 remaining pump stations to increase conveyance to major pump stations and the ESWPAF
  - Pumping capacity
- ESWPAF Upgrades

  - Updates to Facilities Plan based on new wet weather capacity
- CSO Storage Tanks
  - Regulator and CSO Outfall closures
  - Tank location and sizing
- Consolidation conduits, storage tunnels and dewatering pumping stations

The finding of this Screening Level Analysis of Long Term CSO Elimination will be presented in separate Technical Memorandum.

CSO LONG TERM CONTROL PLAN IMPLEMENTATION SCHEDULE AND PROJECT COST ESTIMATE

CSO LTCP COMPONENTS	Million (2016 $)	Grant %	CWF Grant	NH Loan Share	GNH Loan Share	2016	2017	2018	2019	2020	2021	2022	2023-2028	2029- 2034	2035 - 2040
2016 Long Term Control Plan Update															
Short Term Improvements (2016-2018)	***$ 10.4***														
Regulators 012 and 020 Relief Sewers (CWF 2016-02)	5.4	50%	2.7	1.1	1.6										
West River CSO Improvements (CWF 2016-03)	2.5	50%	1.3	0.5	0.8										
Regulator 034 Relief Sewer (CWF 2016-05)	1.0	50%	0.5	0.2	0.3										
Green Infrastructure Improvements (CWF 2016-07)	1.5	50%	0.8	0.3	0.5										
Intermediate Term Improvements (2018-2028)	***$ 98.7***														
Capacity Upgrade of East Street Pump Station	34.8	50%	17.4	7.0	10.4										
Yale Campus/Trumbull Street Phase 2A Separation (CWF 2009-04)	12.0	50%	6.0	2.4	3.6										
Capacity Upgrade of Union Pump Station	17.0	50%	8.5	3.4	5.1										
Capacity Upgrade of Boulevard Pump Station	34.4	50%	17.2	6.9	10.3										
2022 Long Term Control Plan Update	0.5	55%	0.3	0.1	0.1										
Long Term Improvements (2024-2040)	***$323.9***														
Phase II ESWPAF Wet Weather Capacity Improvements	134.2	40%	53.7	32.2	48.3										
2028 Long Term Control Plan Update	0.5	55%	0.3	0.1	0.1										
Phase III ESWPAF IFAS/Incinerator Improvements	34.5	23%	8.1	0.0	26.4										
2034 Long Term Control Plan Update	0.5	55%	0.3	0.1	0.1										
Fair Haven Sewer Separation	94.4	50%	47.2	18.9	28.3										
CSO Storage Tanks/Separation/GI Alternatives	59.8	50%	29.9	12.0	17.9										
Elimination of CSOs during a 2-year, 6 hr storm	**$433.0**	**45%**	**$194.0**	**$85.0**	**$154.0**										

Figure 7-2. CSO Long-Term Control Plan Implementation Schedule and Project Cost Estimate

SECTION 8

Screening Level Analysis of Long Term CSO Elimination

This memorandum documents a screening level analysis for elimination of all CSO discharges from up to and including the 25-year, 24-hour storm within the sewer service area. A screening level cost estimate of improvements required to capture this storm are presented in this Memorandum.

8.1 Rainfall

The rainfall volume was obtained from the Intensity Duration Frequency (IDF) curves generated by Cornell University and the Northeast Regional Climate Center (NRCC). Currently, the volume for a 25-year, 24-hour storm is 5.94 inches of total rainfall. The shape of the hyetograph was generated with a Soil Conservation Service (SCS) Type III rainfall distribution (Type III rainfall distributions occur in the areas of costal New England). The 25-year storm is shown in Figure 8-1 in comparison with the 2-year, 6-hour design storm in 15 minute intervals. Under this design storm, the 2016 Conditions Model produces 84.5 million gallons (MG) of combined sewer overflow (CSOs). In comparison, the existing CSO Long Term Control Plan (LTCP) is controlling about 14.3 MG of overflow for a 2-yr, 6-hr storm.

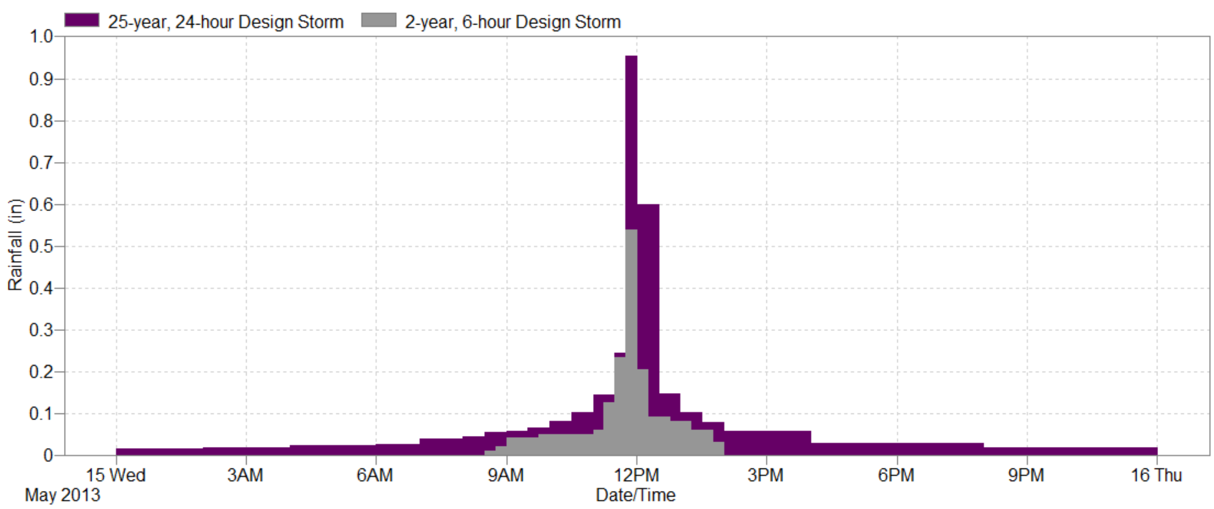


Figure 8-1. 25-year, 24-hour Design Storm

Comparison between the 25-year and the 2-year, 6-hour design storm

8.2 Controls

The existing conveyance and treatment infrastructure is not able to handle the extreme volumes produced by this storm. Hydraulic grade lines throughout the system show us that the recommended LTCP controls in the 2016 LTCP Update maximize capacities of the existing conveyance and treatment infrastructure. Even if all of the recommended LTCP controls are implemented this storm would still produce another 48.6 MG of CSO overflow and 30 MG of manhole flooding. Existing conveyance infrastructure would have to be rehabilitated across the system to remove or convey flows to a consolidation system where flow could be stored until treatment capacity became available.

8.3 Screening Level CSO Elimination Plan

To determine screening level costs to capture a 25-yr, 24-hour storm, the plan contains all the controls listed in the 2016 Long Term Control Plan Report (excluding the storage tanks) plus consolidation conduits, a storage tunnel, a dewatering pump station tying directly into the ESWPAF, and expansion of the ESWPAF to 200 mgd to provide treatment to peak wet weather flows.

8.3.1 Consolidation Conduits

Consolidation conduits connected directly to the CSO regulators would convey flows to a storage tunnel. Three major branches were included to capture flows for the Boulevard Trunk Sewer, East Street and the Fair Haven Sewersheds. The lengths and diameters of the consolidation conduits are shown below in **Table 8-1**.

Table 8-1. Consolidation Conduits

Diameter (in)	Total Linear Feet
36	3,400
60	7,000
72	5,000
84	21,000

The location of the consolidation conduits are shown in **Figure 8-2**.

8.3.2 Storage Tunnel

The amount of CSO volume created by the 25-year, 24-hour design storm that requires storage is 48.6 MG. Tunnel dimensions for that amount of storage are 7,200 feet with a 33-foot diameter. The location of the Storage Tunnel is shown in **Figure 8-2**.

8.3.3 Dewatering Pump Station

Once the overflow is stored in the tunnel, it will require a dewatering pump to empty the tunnel to the ESWPAF once the majority of the wet weather flows have passed through the system. The tunnel should be emptied within 24 hours after the storm event has passed. Therefore, the dewatering pump would be constructed with a 50 MGD capacity to ensure the tunnel is emptied.

8.3.4 Sewer Separation and Rehabilitation

Sewer separation and rehabilitation of over 500 acres would be conducted to remove 30 MG of flooding in areas outside of the CSO regulators. The location of the areas to be separated are shown in **Figure 8-2**.

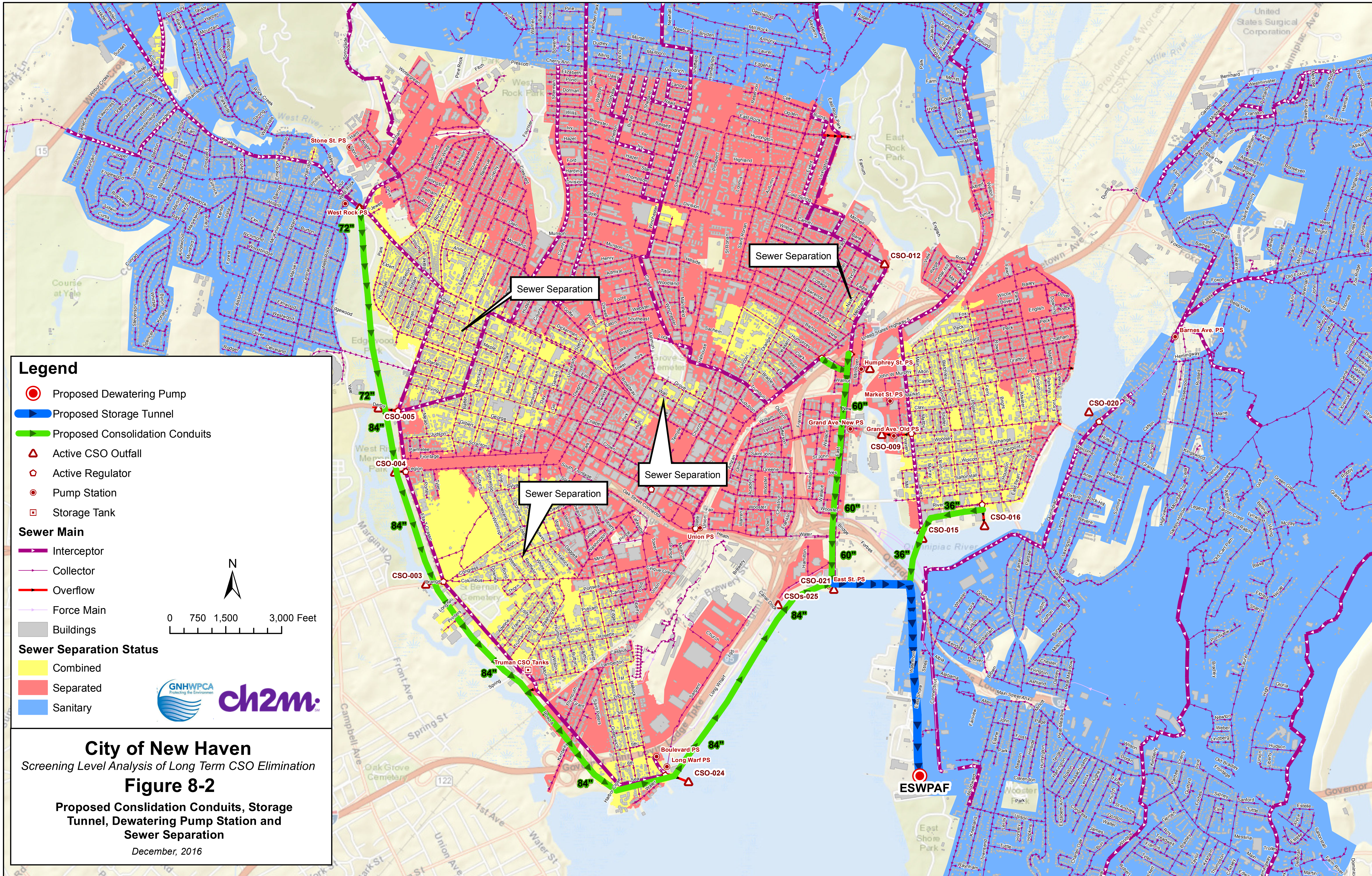
8.3.5 Cost Estimation

The order of magnitude costs presented below are project costs above the required investments of $433 million to control the 2-yr, 6-hour storm. Costs are presented in 2016 dollars and include contingencies and an allowance for engineering and administration.

CSO Control Element	Total Cost
Consolidation Conduits	$525,000,000
Storage Tunnel	$275,000,000
Dewatering Pump Station	$80,000,000
ESWPAF Expansion	$50,000,000
Sewer Separation and Rehabilitation	$250,000,000
Total Project Cost	$1,200,000,000

8.3.6 Summary

This screening level analysis was developed to determine the potential costs associated with controlling a 25-yr, 24-hour storm. This level of control is not yet considered technically feasible due to constructability issues, environmental impacts, land acquisition constraints and verification of geotechnical conditions. Even if all of these technical obstacles could be overcome, an updated Financial Capability Assessment would have to be done to determine whether the program was economically feasible for the City of New Haven rate payers.



City of New Haven

Screening Level Analysis of Long Term CSO Elimination

Figure 8-2

Proposed Conslidation Conduits, Storage Tunnel, Dewatering Pump Station and Sewer Separation

December, 2016

SECTION 9

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